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ANNUAL REPORT

OF THE

MISSISSIPPI RIVER COMMISSION

FOR THE

FISCAL YEAR ENDING JUNE 30, 1894;

BEING

APPENDIX XX

OF THE

ANNUAL REPORT OF THE CHIEF OF ENGINEERS FOR 1894.

C. B. COMSTOCK, Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A., *President*.
CHARLES R. SUTER, Lieut. Colonel, Corps of Engineers, U. S. A.,
AMOS STICKNEY, Lieut. Colonel, Corps of Engineers, U. S. A.,
MR. HENRY L. WHITING, Assistant, U. S. Coast and Geodetic Survey,
MR. B. M. HARROD,
MR. ROBERT S. TAYLOR,
MR. HENRY FLAD,
Commissioners.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

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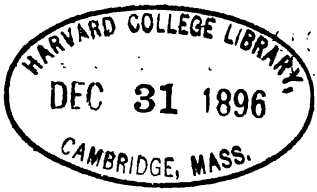

The Miss River Comm

[EXTRACT FROM THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 29, 1894.

* * * * * * *

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission, constituted by act of Congress of June 28, 1879, is in charge of the improvement of Mississippi River between the mouth of Ohio River and the Head of the Passes and of surveys of the entire river.

The commissioners during the past fiscal year were: Col. C. B. Comstock, Corps of Engineers, president; Lieut. Col. Charles R. Suter, Corps of Engineers; Maj. O. H. Ernst, Corps of Engineers (to January 8, 1894), and Lieut. Col. Amos Stickney, Corps of Engineers (from January 30, 1894); Henry L. Whiting, assistant, U. S. Coast and Geodetic Survey; B. M. Harrod; Robert S. Taylor, and Henry Flad.

The report of the commission upon the operations under its charge during the fiscal year ending June 30, 1894, is submitted as Appendix XX.

Estimates for the fiscal year ending June 30, 1896.—The following estimates of funds required for carrying on the works under its charge for the year ending June 30, 1896, are submitted by the commission:

For improving Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$2,665,000
For improving harbors at:	
New Madrid, Mo	75,000
Memphis, Tenn	100,000
Greenville, Miss	200,000
Natchez, Miss., and Vidalia, La	300,000
New Orleans, La	300,000
For improvement at head of Atchafalaya and mouth of Red River, Louisiana	350,000
Total	3,990,000

* * * * * * *

[To be inserted at page 2697 Annual Report Chief of Engineers, 1894.]

ERRATA

IN THE REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1894, AS PRINTED IN THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS 1894, APPENDIX XX.

NOTE.—The following list includes only errors of quantity or sense..

Page 2702.—Under "Levees" etc , 2nd line, for extends from read extends to.

" 2704.—Last line of next to last paragraph, for 269106 cubic yards read 299147 cubic yards.

" 2730.—10th column, 10th line, for .022463 feet. read .022468 feet.

" 2734.—8th column, 6th line, opp. △ Bellevue, for E M. read M. E.

" 2744.—Opposite □ 1^{2} for 42° 52' , read 42° 50', under latitude.

" 2805.—Opposite Donaldsonville, in 3rd and 4th columns for reference note 10, read 9.

" 2833 —1st column, for r, read April.

" 2834.—May 31 and June 1, last column for II and III, read VII and VIII, respectively.

" 2834.—Datum area, May 22, for 256087 read 238087.

" 2835.—Under "Remarks" insert f before "Observed with floats".

" 2836.—Lake Providence gauge reading June 7, for 30.2 feet read 39.2 feet.

" 2836.—In foot note, for "Observed" etc., read These pairs observed etc.

" 2842.—Velocity and discharge, June 16, upper section, for 5.604 and 1084635, read 5.683 and 1089891, respectively.

" 2869.—22nd line for 3300 feet read 300 feet.

" 2877.—Last line, for Gumbyville read Cumbyville.

" 2879.—4th line, under "Summary" for superintending read superintendence.

" 2880.—Quantity of piling under "River Mat," for 46.3 feet read 463 feet.

" 2881.—In table of stone, 1st line, for 18293.64 cubic yards, read 18294.64 cubic yards.

" 2888.—Column of "Coal," opposite "Miscellaneous work" for 205 bushels read 204 bushels.

" 2888.—Column of "Staples," opposite River Mat No. 10 for $797 read $7.97.

" 2888.—Column of "Wire, Iron", opposite River Mat No. 12, for $14.870 read $148.70.

" 2892.—Under "Additional foot mats", 2nd line, for are laid longitudinally, read laid one longitudinally.

" 2895.—Last line of 2nd paragraph, for 3.6 feet read 8.6 feet.

" 2895.—Heading of 3rd column, in table, for Construction and care at quarters read Construction and care of plant.

" 2896.—3rd table, quantity of brush in foot mat No. 2, for 555.3 read 553.3.

" 2896.—3rd table, mat No. 1, cost of nails, for $2.10 read $2.00.

" 2899.—19th line from bottom for (250 × 488) read (250 × 588).

" 2903.—Under "Expended", 4th line from bottom of page, for 1351.81 read 1315.81.

" 2910.—8th line from bottom of "Abstract" for Repairing old work, read Repaving old work.

" 2915.—Last table, bid 18, for 18½ cents read 18⅜ cents.

" 2917.—1st table, time of Chas. Le Vasseur, for $4\frac{1}{10}$ months read $9\frac{9}{10}$ months.

" 2921.—Under Lake Providence Reach, change period to comma at end of last sentence and add but the subaqueous mat appears to be intact.

" 2921.—Last line for was read were.

" 2923.—3d line of table, for 361 miles, read 371 miles; also in same table, total column of Barnes Landing, for $45,524 read $4,552.40, and of Warfield Point, for $12,268 read $1,228.80.

Page 2926.—12th line from bottom, omit the word levee, first word of line.

" 2927.—In table under locality, for Station 1845 — 50 read Station 1845 + 50.

" 2931.—11th line under Lake Bolivar Front, for October 28 read October 23.

" 2936.—12th line from bottom, for 19458 cubic yards read 1945.8 cubic yards.

" 2937.—In table material used, for Revetment (300 squares repaired) read Revetment (900 squares repaired).

" 2941.—In heading of table, for material used per 1 inch foot, read material used per linear foot.

" 2941.—1st line of 2nd table, for 1 foot read linear foot.

" 2943.—6th line, for $0.0353 read $0.353.

" 2943 —1st line of 2nd table, for 9.13 read .913.

" 2943.—9th line of 2nd table, broken type, should read 24,595.

" 2945.—1st table 3rd column, omit †, thus; for †2 read 2.

" 2945.—3d line below 1st table, for t read to.

" 2947.—5th line from bottom, for 1883 read 1893.

" 2948.—1st line, put comma after word maximum.

" 2948.—17th line, for 1882 read 1892.

" 2955.—10th line, for Barge No. 8 read Barge No. 80.

" 2955.—11th line for 39.6 read 39.86.

" 2955.—After 24th line, to supply omission, insert Barge No. 546 calked above light water $95.60.

" 2959.—3d line under Lake Bolivar Front, for $17,622.88 read $17,622.80.

" 2961.—14th line, for May 3 read May 31.

" 2963.—Bid No. 6, Warfield Point, for 18½ read 12½.

" 2969.—In table of gauge heights at Cairo 1893, for 40.3 feet read 49.3 feet; also at Lake Providenee 1893, for 41.35 feet read 41.85 feet.

" 2971.—Last column of table, 7th line from bottom for 3.00 feet read 3.10 feet.

" 2973 —5th column, on line with April 25, 1889, for 3.43 feet, read 3.48 feet.

" 2980.—Opposite Nereaux in 2nd table, 4th column, for March 11 read March 1.

" 2980.—Opposite Harroll 3d column for 145 feet read 445 feet.

" 2983.—1st table, opposite College Point, date of completion in last column, for 1893 read 1894. Also in same table, opposite Home Place, date of contract 3d column, for 1893 read 1892.

" 2997 and 2998.—The distance from Cairo of Towles to Billings should be 851.5 instead of 815.5 and 858.5 as printed.

" 2998.—Opposite Linwood in 2d table, 6th column, for 12.30 read 12.39.

" 2998.—In 3d table, 3d column 1st line, for April 25 read April 28.

" 2999.—2d table, transpose the headings of columns 6 and 7; 6th column should be headed Barataria and 7th column should be headed Lake Borgne.

" 3011.—3d line, 3d paragraph under "Repairs" for cut read cuts.

" 3012.—16th line from bottom, last word, for inches read feet.

" 3015.—1st line 3d paragraph omit comma after lower.

" 3015.—1st table, 8th column, for 260 feet read 280 feet, opposite Reserve.

" 3015.—Same table, opposite St. Clair 2d column, for 962 miles read 982 miles.

" 3016 —In 5th column, opposite Hard Times, for 4 to 200 feet read 4 to 20 feet.

" 3019.—Under the head "In general" 4th line, for 0.02 feet read 0.2 feet.

" 3025.—Under Lake Borgne District, 1st line, for 988.5 miles read 968.5 miles.

" 3030.—Bid No. 30, for 16¾ cents read 15¾ cents.

" 3034.—Bid No. 21, 4th column, for $7,825.00 read $7,825.00, under "Rescue".

" 3037.—Bid No. 14, Nereaux levee, last column, for $22,296.25 read $12,296.25.

" 3037.—Bid No. 15, St. Louis levee, 3d and 4th columns for 15.02 cents read 15.2 cents.

" 3044.—Bid No. 20, Sugarhouse levee, for 11.98 cents read 14.98 cents.

" 3044.—Bid No. 23, Towles to Billings, for $2,200.00 read $2,220.00.

Page 3046.—Bid No. 22, 5th column, for 10.99 cents read 19.99 cents.

" 3049.—Bid No. 14, Hope levee, 4th column, for $1,820.00 read $1,920.00.

" 3049.—Bid No. 20, Rost levee, 4th column, for $3,484.30 read $3,484.80.

" 3051.—Bid 14, last column, for 6225.00 read 6255.00.

" 3053.—1st table bid No. 2, 3d column, for 9.30 cents read 9.39 cents.

" 3053.—1st table bid No. 5, 5th column, for $4,649.51 read $4,649.50.

" 3053.—2d table bid No. 8, 6th column, for 11.07 cents read 11.7 cents.

" 3054.—2nd table bid No. 2, last column, for $4,071.91 read $4,671.91.

" 3056. Under Vidalia, tonnage of molasses, for 43 tons read 48 tons.

" 3059.—Under "Plaquemine", value of cargo shipped, 1893, for $1,254,614.00 read $1,264,614.00. In same table, value of cargo received and shipped in 1892, for $1,850,722.00 read $1,856,722.00.

" 3060.—Under "New Orleans", value of staves, for $302,880, read $302,880.

" 3061.—The number of steamboats in local trade below New Orleans in 1894 should be 8.

" 3064.—Omit the sign $ after levees and readings on 3rd and 4th lines.

" 3067.—Last table, for April 20, 1871, read April 19, 1871.

" 3069.—3d paragraph, 3d line from end, for could read would.

" 3069.—19th line from bottom, for .of the levees read or the levees.

" 3071.—End of 2d line of note at top of page, for or read of.

" 3071.—In table of Bougere Crevasse Dec. 6 to 7, 1893, in column of mean depth, section 2, for 49.8 feet read 49.6 feet.

" 3071.—In table of Morganza crevasse, area of section No. 10, for 109,869 sq. ft. read 109,669 sq. feet.

" 3072.—Section 7 in 1st table, mean depth, for 37.7 feet, read 37.6 feet.

" 3072.— " 0 in 2d table, 2d column, for 8300 feet, read 8600 feet.

" 3072.—1st table, 3d column, Sept. 15-19, read Sept. 15-18.

" 3073.—Where days of the month are given under "College Point", for hyphen read and.

" 3073 and 3074.—In tables "Belmont" and "Prospect" the mean areas should both include section F.

APPENDIX XX.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

STEAMER MISSISSIPPI, *June 29, 1894.*

GENERAL: The Mississippi River Commission submits as follows its annual report for the fiscal year ending June 30, 1894:

No appropriation was made within the last fiscal year of money to be expended by or under the direction of or recommendation of the Commission. At the date of the last annual report there remained unallotted of the appropriation of $2,665,000 to be expended on the Mississippi River below Cairo, provided by the act approved March 3, 1893, the sum of $206,000, of which $150,000 was held to await the results of dredging experiments then in contemplation and hereinafter referred to. From this balance the following allotments have been recommended and made at the dates named:

September 30, 1893, to Lake Providence Reach	$10,000
November 2, 1893, to Plum Point Reach	50,000
January 6, 1894, to Plum Point Reach	15,000
March 7, 1894, dredging experiments	10,000
	85,000

SURVEYS, MAPS, GAUGES, AND OBSERVATIONS.

Triangulation.—During the past year this work has been extended to a base line near Prairie du Chien, Wis., a distance of 65 miles. The whole line now complete from the Head of the Passes covers 1,740 miles.

Topography and hydrography.—During the year 184 square miles of topography and 31 square miles of hydrography have been completed upon the Upper Mississippi, closing at stone line 132, one mile above Keithsburg, Ill., the distance covered being 63 miles by the river.

The party engaged in this work then took up the work determined upon by the Commission, from the Head of Passes northward, and carried it to Donaldsonville, 175 miles, where it joined the work of 1882. This work included a portion of Cubitt's Gap, the Jump, Lake Borgne Canal, the city of New Orleans, Lake Ponchartrain from Milneburg to Manchac Pass, through the Pass to Lake Maurepas, and along the south shore of that lake to Amite River, comprising 432 square miles of topography and 89 square miles of hydrography. The topography and hydrography now complete extends from the Head of the Passes to Keithsburg, Ill., a distance by river of 1,515 miles.

Precise levels.—These are now complete from the outer end of the East Jetty at the mouth of the Mississippi to St. Paul, Minn., a distance of 1,982 miles. Side lines have been run from Carrollton, La., to Biloxi, 87 miles; from Savanna to Lake Michigan, at Chicago, Ill., 148 miles; and St. Paul to Lake Superior, at Duluth, 156 miles; making a

total of 2,373 miles. During the past year a duplicate line was run from the Head of the Passes to the outer end of the East Jetty, a distance of 13 miles. The main object of this resurvey was to elicit some information bearing upon the question of the stability of the land about the mouth of the river. In the report of Assistant Engineer Ockerson, appended to the report of the secretary, a number of figures and comparisons are given, based upon this survey and prior ones, indicating a progressive depression of the alluvial delta near the mouth of the river.

Gauges.—A trip of the steamer *Patrol* in connection with the topographical and hydrographical work done between the Head of Passes and Donaldsonville was utilized for the inspection and repair of all the gauges under the charge of the Commission between St. Louis and the gulf. Each gauge was tested and repaired, gauge bulletins put in order, and observers' notes examined.

The daily record of stages at 31 stations on the Mississippi River and 26 stations on the principal tributaries (not including the Missouri) have been reduced, tabulated, and plotted. The stages for the calendar year 1893 have been published, and a table of the highest and lowest readings has been prepared.

Discharges.—Discharge observations were taken at 7 stations on the main river and 3 tributaries, and the results reduced and tabulated. Discharge observations at Clarendon, on the White River, and Little Rock, on the Arkansas River, were made in May, 1893.

Maps.—Detailed charts, scale 1:20000, Nos. 131 to 136, inclusive, from Quincy, Ill., to head of Des Moines Rapids, have been completed. Inch: mile maps, Nos. 110 to 115, inclusive, from Grafton, Ill., to Gregory, Mo., have been completed. It was determined at the last meeting of the Commission to prepare and publish a map of the Mississippi River from Cairo to St. Paul similar to the map of the Alluvial Valley published several years ago, and the work of its preparation is in progress. During the year maps have been published as follows: Detail charts, 1:20000, Nos. 117 to 130, inclusive, from mouth of the Missouri to Quincy, Ill., and Inch: mile map Nos. 101 to 113, inclusive.

The published maps issued by the Commission now comprise the large wall map of the Alluvial Valley from Cairo to the gulf; the topographical map, scale 1 inch to 1 mile, from Hannibal, Mo., to the Head of the Passes, in 45 sheets, and the topographical and hydrographical map, scale 1:20000 from Quincy, Ill., to Donaldsonville, La., in 97 sheets, with 2 index charts.

Tonnage and traffic.—The attempt has been continued to collect reliable data of the transportation carried on upon the river, and statistics upon that subject will be found in the report of the secretary. One table given shows that since 1888 the average cost of the transportation of wheat from St. Louis to Liverpool, via New York, has exceeded the cost via New Orleans about 50 per cent.

Further details of the matters herein mentioned will be found in the report of First Lieut. Geo. A. Zinn, secretary of the Commission, and the reports of his assistant engineers thereto appended. (Appendix 1.)

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND NO. 40, 220 MILES).

Columbus, Ky., 21 miles below Cairo.—The work of improvement at this point consists of five spur dikes of brush and stone, built in 1889 and 1890, to protect 2,200 feet of bank, in front of the town, which threatened to cave. Since the date of last annual report, the founda-

tion mattresses of the three lower dikes have been undermined at their edges above low water by caving of the unprotected bank between them. With this exception the condition of the dikes remains unchanged. No repairs are at present deemed necessary.

Hickman, Ky., 36 miles below Cairo.—The acts of 1886 and 1888 contain specific appropriations for this locality, amounting together to $88,750. The evil to be remedied was the caving of the bank in front of the town. Owing to the existence of a projecting point of tough clay above the landing, it was possible to accomplish the desired result with an unusually small development of work. A continuous revetment, about 1,000 feet long, extending downstream from the clay point, was placed in October, 1890. It has accomplished its purpose, but it is possible that an extension, both in length and width, may be required, as the floods have damaged the downstream end and increased the depth along the outer edge.

A survey is now in progress to determine what further extension, if any, is required. The repairs so far necessary at the lower end were made in 1892, and additional stone ballast was distributed over the shore mat at the same time.

New Madrid, Mo., 71 miles below Cairo.—The river and harbor act of July 13, 1892, contained a special appropriation of $25,000 for the improvement of this harbor. The evil to be remedied was the invasion of the town from year to year by a caving bank. As the sum appropriated was only 25 per cent of the amount required to protect the whole town, and as the length of the revetment that could be constructed would afford only partial protection wherever placed, it was deemed best not to locate the work at the most important part of the landing, but to place it at the upstream end with a view of extending it downstream the requisite distance under appropriations to be made in the future. This project was executed during the past season and 900 linear feet of bank revetment was constructed beginning at the upper limit of the town at Dry Bayou. The subaqueous mattress was 250 feet wide and was the first experiment on a large scale of a mattress built up of brush fascines. Its cost, which was $27.78 per linear foot of bank protected, is therefore greater than that of similar work done later in the season in Plum Point Reach. The work is in good condition.

Plum Point Reach, 147–186 miles below Cairo.—The works thus far undertaken in this reach extend over a distance of about 20 miles. They consist of bank revetments for the protection of caving banks and of dikes and spurs designed to close side channel and to contract the waterway where the width of it is excessive. They are all intended to cooperate in confining and directing the channel throughout the limits of the reach. The principal works in the reach are the following, beginning at the upstream end:

Daniels Point revetment.—This was constructed in 1889 and 1890, and covers about 1 mile of bank at the foot of a caving bend. Its object is to maintain a fixed direction of approach at the head of the reach. It is in a very exposed position and is liable to attack by the caving of the bank at the upstream end and by scour at the outer edge of the mattress. Mattress has been destroyed from both causes. A small break near the upstream end was repaired in 1891, and extensive repairs along the whole length of the revetment were required in 1892. A careful examination after the flood of 1893 showed that the subaqueous mattress had settled at a number of points and that the shore mats had sustained considerable damage. As the work has been so far held with

difficulty, and as the subaqueous mattress had less width than later experience has shown to be necessary in exposed situations, a thorough repair of the revetment after the 1893 flood would have required the construction of new and wider mattresses and an almost complete regrading and repaving of the upper bank. The cost of these repairs would have been greater than for an original revetment of the same length on account of the irregular shapes which the breaks had given to the bank line. For this reason no repairs were made during the season, it being deemed most advantageous and economical to allow the revetment to yield to the attacks upon it and to restore it by new work after the original revetment had all been destroyed and the bank line had again assumed a uniform shape. At a recent inspection the work appears not to have suffered much damage by the moderate stages of the past high-water season.

Ashport Bend revetment.—The work was commenced in 1891 at the upper limit of caving, and 3,250 linear feet was built that year. Its extension down the stream was actively pushed during the season of 1892, and 8,500 additional feet of bank covered before the season was closed by high water in February, 1893. The lower end was in an exposed situation, and during the flood of 1893 was undermined for a distance of 1,400 feet by a deepening of the river bed at the end of the mattress. This deepening amounted to an average of 32 feet, with a maximum of 50 feet, giving depths exceeding 100 feet below low water. In settling, the mat separated from the shore paving and the latter was also destroyed. During the past season the revetment so undermined was restored by new mattresses of greater width, and 3,980 additional feet of bank was covered before the end of the season in January, 1894. This leaves only about 1,340 feet to complete the original project. The mattresses used during the season were of the fascine type, and all were 300 feet wide.

Gold Dust dikes, dikes in chutes of Elmot and Island 30, Gold Dust Dam.—The closure of the chute behind Elmot Island was included in the earliest project of the commission for the improvement of Plum Point Reach. The first effort was the construction of the Gold Dust dikes, commenced in 1882 at the head of the chute. These dikes caused heavy deposits, but did not completely close it. To aid in increasing the deposits still further two cross pile dikes were constructed in 1889 and 1890 across the chutes of Elmot and Island 30, through which Gold Dust Chute returns its flow to the main river. These dikes were raised to extreme high-water level. Both were broken through in 1890 by accumulated drift and were repaired the same year. Both were again breached in 1891 and about one-half of each dike was lost. No repairs have since been made, but even in their broken condition the dikes have materially checked the current and have caused new deposits above and below them. To hasten the filling of the chute and to raise the deposits to a higher level than the pile dikes themselves seemed able to effect, the commission, in 1892, directed the construction of a solid dam of brush and stone 16 feet high above low water across the main chute behind Elmot Island and at its narrowest point. The stone required was stored on the banks during the high water of 1892 and the dam was constructed in the fall of 1893. As completed it consists of a sill mattress 50 feet wide and 2½ feet thick, extending from bank to bank, and on top of this of enough layers of mattresses of like width and thickness to bring the dam to the required level. The mattresses in each layer are placed 8 feet farther upstream than those in the next lower layer. Below the sill

mattress is an apron mattress, almost 50 feet wide and 2½ feet thick, extending the whole length of the dam. Below this is an auxiliary apron mat 25 feet wide and 1 foot in thickness and of sufficient flexibility to follow any scour that may be produced at its edge by the over-fall. The dam is about 3,000 feet long, 13.3 feet or 5 mattresses high on the Tennessee side, and 11.6 feet or 4 mattresses high at the Elmot Bar end. Its least height is 3 feet at the crest of the middle bar. As the river was low during the entire period of construction, it was possible to build all the mattresses, including the sill and apron mats, in place in the dam. The stone was distributed by means of a double track and dump cars operated by hoist engines on the bank. For convenience in handling the stone was distributed over the third and fifth mattresses of the dam on the Tennessee end and all of it was distributed over the top mattress on the Elmot Bar end. The apron mats were also heavily ballasted. The banks at both ends of the dam have been protected by brush and stone mattresses for a distance of 100 feet above and 300 feet below the center line. In its construction were used 17,800 cords of brush and pole and 19,000 cubic yards of stone. The total contents are 102,082 cubic yards and the total cost $92,777.13. Some settling has taken place during the past high-water period, as was to be anticipated. At one end near the Tennessee shore it has settled the full height of the dam and at another point, near the Elmot Bar, 5 feet. With these exceptions the settling is moderately uniform, averaging from 2 to 3 feet. Such additional work will be done the coming season as may be necessary to restore the dam to its original grade.

Fletchers Bend revetment.—This revetment was commenced in 1884 and added to at different times until its present length of 16,500 feet was reached in 1891. Beginning at the upstream end the revetment is continued for a distance of 12,000 feet. Below this the mattresses were laid in four detached blocks, with intervals of 300, 400, and 500 feet between them. The continuous mattress is in good condition, but the detached mattresses have been undermined and injured at the ends by caving in of the unprotected bank between them. It is proposed to cover these intervals and convert the detached blocks into a continuous revetment as soon as circumstances will permit. The break at the upstream end of the upper piece of detached mattress has been repaired with a mattress 595 feet long and 250 feet wide.

Plum Point revetment.—This revetment, constructed in 1888, is located below the mouth of Island 30 Chute, and is 800 feet long. About 12½ per cent has been lost by undermining at the downstream end. The remainder is in good condition.

Plum Point dikes.—No work has been done on these during the year. From present indications the low-water channel of the coming season will be close to the ends of the three upper dikes. In that event some work may be necessary to maintain the ends of the dikes, all of which have become weakened by age.

Osceola Bar revetment.—This bar is protected at the upstream end by 4,339 feet of revetment, placed in 1893 and 1894, with mattresses 100 and 150 feet wide, and at the lower end by 5,987 feet of revetment, with mattresses 200 feet wide, constructed in 1890 and 1891. The upper revetment is protected by an outlying sand bar from a strong attack of the current. Both works are in efficient condition, and no additional work is at present required.

Revetment Bullerton Tow-head.—The original revetment of the channel face of this tow-head was built in 1882–1884, and was 10,000 feet long.

For some years after its construction it was protected from any considerable attack of the current by an outlying sand bar. In 1892 this bar was washed away, and the revetment was breached in a number of points by the flood of 1893. The mattresses were among the first constructed by the Mississippi River Commission, and had a width of only 100 feet. Later experience having shown this width to be much too small, it became necessary to renew the revetment by mattresses of greater width and strength than those of the original work. Under an allotment for that purpose the work of renewal was commenced last season, and 4,018 linear feet of bank at the upstream end of the tow head was covered before the close of the season in January, 1894. The mattresses were four in number and all 250 feet wide. The first three were respectively 1,243, 1,044, and 1,203 feet in length, and were constructed with the facines normal to the bank. The last mat was 588 feet long, and was constructed with the facines parallel to the bank. The face of the tow-head in the chute was protected for a distance of 90 feet by a mattress and shore paving. The work is in good condition, and will be further extended the coming season. The cost per linear foot of bank protected last season was $21.98.

Results in Plum Point Reach.—The lowest stage reached in the fall of 1893 was 0.88 above zero on the local gauge. The lowest recorded depths were 8 feet at Island 30 crossing and 9 feet at the foot of Gold Dust crossing.

These depths were taken at falling river September 20 and 21, with 1.3 feet on the local gauge. They were subsequently improved as the channel became more clearly defined.

The least depths after the river reached its lowest point were 9 feet at Island 30 and about 10 feet at all other points. The extension of the Ashport Bend revetment produced a marked improvement in Gold Dust crossing. In 1891 the least depth on this crossing was 6½ feet; in 1892, 7½ feet, and in 1893, 9 feet, falling river in September, and 10 feet after the channel had become well defined. The good results heretofore reported have therefore been well maintained.

Levees Lower St. Francis Basin levee district.—This district begins at the high ground at Point Pleasant, Mo., and extends from the mouth of the St. Francis River a distance by river of 218 miles. Levees have been constructed during the season by both the Government and the local levee boards in Missouri and Arkansas. The Missouri board, with no funds in hand, has succeeded in constructing 21 miles of complete and 7 miles of incomplete levee, aggregating 638,816 cubic yards. The work was done by the planters themselves, who, having lost their crop by the late overflow of 1893, utilized their force in constructing levees along their respective fronts, receiving in payment levee-board certificates of indebtedness to be paid for out of the future revenues of the district. The levee built by this board is concentrated in two blocks, one 8 miles long below Point Pleasant and the other 20 miles long from a point 2 miles below Gayoso to a point 1½ miles below Cottonwood Point. In both blocks there are pieces of incomplete levee and points where no work has been done amounting to a total length of 7 miles. These gaps are to be closed the coming season and as much more levee will be built as the district can pay for out of any funds it may be able to borrow. The Arkansas board has constructed 1¾ miles of levee, containing 83,000 cubic yards, at the head of the bend of Island 35. A much larger amount of work was contemplated and a much larger amount would have been done but for the litigation in which the board became involved, which compelled a cessation of the work until the con-

stitutionality of the levee-board act could be established. This board is negotiating for a considerable loan, and if successful will do a large amount of work the coming season.

Under the allotment of $88,000 for the fiscal year ending June 30, 1894, the Government has constructed during the year over 4 miles of levee in the vicinity of Bear Bayou (153 R.). The allotment for the fiscal year ending June 30, 1895, has been placed under contract, and will be expended in extending still farther northward the levee constructed the past season. The work done by the Government and the local districts during the year amounted together to 1,148,000 cubic yards.

Surveys, gauges, and observations.—The surveys include the usual hydrographic survey of Plum Point Reach at low water, and special examinations of the revetments at New Madrid, Mo., Daniels Point, Ashport Bend, Osceola Bar, and Bullerton Bar; also observations, when practicable, of the shoal crossings in Plum Point Reach. For details of the operations in the first district see report of Capt. S. W. Roessler, hereto appended. (Appendix 2.)

SECOND DISTRICT (FOOT OF ISLAND NO. 40 TO MOUTH OF WHITE RIVER, 189 MILES).

Revetment Hopefield Bend, 225 miles below Cairo.—The revetment of this bend is intended to cooperate with the local work along the front of Memphis. It was commenced in 1882, and, except when revetment work was interdicted by Congress, was continuously prosecuted to its completion in 1889. Its length is over 3 miles. The upstream third is at present protected by a sand bar, and though the shore mattresses here have been injured and the mattresses below low water have less strength and width than later experience has shown to be necessary, no repairs have been made, and none will be needed as long as the bar remains. The lower 2 miles of the revetment have been subject to the attack of a very rapid current, and such injuries have been caused and such repairs made as have been described in previous reports. The repairs made up to the date of the last annual report included a complete renewal of the lower 2 miles of revetment except two pieces, one 2,000 feet and the other 500 feet long, near the downstream end. Both pieces were breached by the water of 1893, and were repaired last fall by new work with mattresses of the fascine type 310 feet wide. The work of the season included also an extension of the revetment 500 feet farther downstream, to cover the lower side of Hopefield Point, which had shown a tendency to cave. The present condition of the work is good.

Memphis Harbor, 230 miles below Cairo.—A full description of the sand bar which obstructs a portion of the public landing is given in previous reports. In its present development it covers over a mile of the city front below the mouth of the Wolf River and obstructs the landing at the elevator and about two-thirds of the paved levee. A farther growth of the bar down the levee may be anticipated, but without much increase in width. The boats seeking this port at the next low water will probably not all be able to effect a landing, as they have done heretofore, close up against the pavement. The evident solution of the difficulty for this year, and for several years to come, will be to use the requisite number of wharf boats, which, as the bar is now, can be easily connected with the paved levee by landing stages of bridges. Then, at some future time, when the bar has expanded to its full length

and width, the wharf boats can be again dispensed with by extending the paving of the levee out to the edge of the bar.

The river frontage of the city extends from the mouth of Wolf River to the Kansas City and Memphis Railroad bridge, and is 13,300 feet in length. Of this, 9,500 feet of bank has been protected from caving as follows: From the mouth of Wolf River to the foot of Beal street it is protected by a continuous revetment, which was commenced in 1878 and completed in 1887; for a distance of 2,100 feet below Beal street it is protected by the citizens' dikes, constructed in 1886 and 1887, and for a distance of 1,000 feet above the bridge it is protected by a continuous revetment, constructed by the bridge company as a protection of its shore, pier, and abutment.

The only part of the city frontage remaining unprotected is that included between the citizens' dikes and the bridge revetment, and is 3,800 feet long. The caving of this bank, formerly slow, has become more active during the past year. The commission in its last annual report included an estimate of $100,000 to complete the protection of the city front.

Nonconnah Rock, 263 miles below Cairo.—Contract was made during the last fiscal year for the removal of this obstruction to the channel on the left of Presidents Island. Work was commenced at low water in September and continued through October and a part of November. The work presented difficulties not anticipated by the contractor, and but little progress was made. Only 335 cubic yards of the rock have been removed, and its height has been reduced only 3½ feet. The work will be continued at next low water.

Helena Harbor, 306 miles below Cairo.—This work remains in the condition described in the last annual report of the Commission. It consists of a continuous revetment 600 feet long and five spur dikes, constructed in 1889 and 1890 to protect 3,000 feet of caving bank in front of the town. The lower end of the work is still incomplete, but the objects sought seem fairly accomplished, and no further work is n contemplation at present.

LEVEES.

In the second engineer district are included the lower part of the St. Francis Basin, to which allusion has been made in the report of the first district, also the Upper Yazoo levee district on the left bank, and upper and lower White River levee districts on the right bank.

Work has been done during the year upon both fronts under contracts in force at the date of last annual report.

Upper Yazoo levee district, 244 to 365 miles below Cairo.—This district has a river frontage of 120 miles, and contains 110 miles of levee. The levees are in a higher state of efficiency than in most other parts of the system. They have generally grades 3 or 4 feet above the highest recorded water, full crown and section, and banquettes where the height makes desirable. All the contracts in force at the date of last annual report have been completed.

They include the enlargement and raising of 10 miles of the existing levee and the construction of a new loop 3,000 feet long where the old levee was threatened by a caving bank. The work done in the past season by the Government was 521,800 cubic yards and by the local authorities 269,106 cubic yards.

Under the provisions of the river and harbor act of July 13, 1892, the allotment of $100,000 for this district for the fiscal year ending June 30, 1895, less 10 per cent, has been put under contract and will be expended in enlarging the existing levees from Austin, Miss. (289 L.),

northward over a distance by levee of 20 miles. The grade here has been fixed at 5 feet above the highest recorded water to provide against the increased height of water that will be felt in this vicinity when the levees in the St. Francis Basin are completed.

Upper White River levee district (306 to 340 miles below Cairo).—The existing levee begins at the foot of Crowleys Ridge, at Helena, Ark. (306 R.), and at the date of the last annual report had been extended to Yellow Banks Bayou, a distance by levee of 22 miles. During the past season the levee has been extended southward 6,500 feet by a new levee, and the existing levee for a distance of 8,045 feet above the bayou has been raised and enlarged. The levees constructed the past year have been raised to a grade 3½ feet above the highest recorded water, which in this locality was that of 1890, and were made 5 feet wide on top, with side slopes of 1 in 3.

For the projected work of the coming season the section will be the same, but the grade will be raised to 4 feet above the 1890 water. The work of the past year was 269,106 cubic yards. None was done by the local authorities.

The allotment of $53,000 for the fiscal year ending June 30, 1895, has been put under contract and will be expended in extending the levee farther southward a distance of about 4 miles.

Lower White River levee district, 340 to 385 miles below Cairo.—At the date of last annual report the levee in this district had been developed to a length of 21.5 miles and had been extended northward to a point opposite the head of island No. 58 (362 R.). During the past season the levee has been extended 20,000 feet, or nearly 4 miles, farther northward to a point opposite Offuts Landing (346 R.), and 7,200 feet of existing levee near Laconia Bar has been raised and enlarged. No work has been done by the local authorities except on the private levee of the circle. That of the Government was 430,173 cubic yards, of which 49,198 was enlargement and 380,975 new levee.

The allotment of $75,000 for the year ending June 30, 1895, less 10 per cent, has been put under contract and will be expended in enlarging the Big Henrico levee near Henrico Landing (383 R.) to the extent of 50,000 cubic yards, and in extending the upper end of the system 16,700 feet farther northward.

The projected work for the coming season in the two White River districts will reduce the gap between the two levee systems to a length of 9¾ miles.

Surveys, gauges, and observations.—The surveys of the year in this district include a special examination by soundings of the revetment at Hopefield Bend, a survey of Nonconnah Rock, a hydrographic survey of the river from Old Town, Ark., to Knowltons, Ark., a distance of 40 miles, and a survey of location for a levee to connect the levee systems of the upper and lower White River levee districts. All the crossings and shoal places within the limits of the first and second districts were located and sounded by the survey party in September, 1893.

For details of the operations in the second district, see report of Capt. S. W. Roessler, hereto appended. (Appendix 2.)

THIRD DISTRICT (MOUTH OF WHITE RIVER TO WARRENTON, MISS., 220 MILES).

Lake Bolivar front, 417 miles below Cairo.—This work, consisting of 4,250 linear feet of revetment, intended to protect the lake Bolivar levee and its site, was constructed in 1889. It has accomplished the purpose

for which it was built. During the past season it has been repaired by constructing at the lower end of the work a subaqueous mat 685 feet in length at a locality where the river currents had undermined the outer edge of the revetment previously constructed. Minor repairs were also made to the upper bank revetment, 239 cubic yards of stone being expended for the purpose.

Ashbrook neck, 446 miles below Cairo.—As explained in the last annual report, the protection of the upstream side of this neck had become necessary in order to prevent a cut-off. The work was begun in 1890. Eight thousand nine hundred linear feet of revetment were constructed. During the past season 972 cubic yards of stone have been added to the upper bank revetment at localities at which insufficient stone had been placed during its construction. A small extension at the upstream end is proposed during the coming year.

Greenville Harbor, 478 miles below Cairo.—The object of this improvement is the protection from caving of the bank in front of the city of Greenville. In 1887, 1888, and 1889 there was built along the city front a system of spur dikes which afforded immediate relief, but it was soon apparent that the caving in the bend above was so rapid that to preserve the existing work it was necessary to revet the bend to a point where the caving was not active. This work was commenced in 1891 and continued during the next season, 11,050 feet of bank revetment being constructed.

During the past fiscal year minor repairs have been made to the upper bank revetment where it had been damaged by excessive rains. During a recent rise in the river the upper dike at Greenville has been severely damaged.

The continuous revetment immediately above has also settled, the subaqueous mat separating from the upper bank revetment. This action appears to be extending upstream.

Repairs will be made at this locality during low water. The revetment will also be extended upstream as far as the funds appropriated will admit.

Lake Providence Reach, 517 to 552 miles below Cairo.—A description of the earlier works in this reach will be found in the annual reports for 1891 and previous years. The existing project, adopted in 1889, contemplates the revetment of caving banks, commencing at Louisiana Bend, the head of the reach. Work was continued in this bend in 1891 and 1892 and 3½ miles of the bank revetted.

During the past year work has been confined to repairs to existing work. Five brush and stone dikes were constructed in the rear of the revetment across the mouth of Old River and the two built last season extended to prevent the undermining of the work by the flow into and out of Old River during floods. The upper bank revetment below Old River was repaired where it had been damaged by a settlement of the unstable material on which the riprap had been laid and stone added to the mat constructed at the close of last season's work, which was sunk at a high stage of the river when a proper disposition of the stone could not be made.

Delta Point and Vicksburg Harbor, 599 miles below Cairo.—The holding of Delta Point, opposite Vicksburg, has been an essential condition of all projects for the improvement of Vicksburg Harbor. Any further recession of this point would materially increase the cost and difficulty of any plan for the improvement of the harbor.

The Delta Point revetment, covering 10,700 linear feet of bank, was constructed between 1878 and 1884. It has required no repairs for

several years, but its permanence has been threatened by a considerable scour along its outer edge. To prevent this undermining action 1,000 feet of mat, 300 feet wide, has been sunk at the upper end of the work during the past season. The revetment above low water, which was originally of brush weighted down with stone, has been replaced by a riprap of 10 inches of stone wherever the brush has rotted out and the bank become exposed to river currents.

The plan of the Commission for the improvement of Vicksburg Harbor consisted in dredging a canal from the main channel of the river at Kleinston to the east end of Centennial Lake, and a turning basin in front of the city, which were to be of navigable width and depth at the lowest stages of the river. To prevent the inflow of silt-bearing currents during higher stages the canal and basin were to be inclosed by a dam constructed from the material dredged. Work on this project was begun in 1887 and continued as appropriations became available to the close of the last fiscal year.

The river and harbor bill of July 13, 1892, adopted another plan for the improvement of Vicksburg Harbor and made an appropriation for its execution. This project contemplates the diversion of the Yazoo River into Centennial Lake and along the city front. As explained in the last annual report this project is incompatible with the one adopted by the Commission, and upon the completion of the contract then existing dredging in Vicksburg Harbor was suspended.

Levees, Lower Yazoo district.—This district extends from the boundary line between Bolivar and Coahoma counties, Miss., to the mouth of the Yazoo River. With those of the Upper Yazoo district its levees complete protection of the Yazoo Basin. The length of its levee line is about 190 miles. During the last fiscal year the Government work has consisted in raising and enlarging about 27 miles of levee at the upper end of the district, the enlargement containing 786,642 cubic yards of material. The local authorities have erected during the same period 877,128 cubic yards, enlarging 17 miles of old levees, and constructing loops at localities where the levee line was threatened with destruction from caving banks.

Levees, Upper Tensas district.—This district includes the portion of the Tensas Basin, in the State of Arkansas. It extends from the Arkansas River to the boundary line between the States of Arkansas and Louisiana.

To protect this region from overflow two systems of levees are required—one along the Arkansas River, the other along the Mississippi. The head of the Mississippi levee line is at Amos Bayou, about 17 miles south of Arkansas River, on a ridge which in 1882 was not overflowed. The length of the Mississippi line is about 84.8 miles. The work of the General Government has heretofore been confined to this portion of the district. During the past fiscal year an allotment of $300,000 has been expended in closing the crevasses which occurred during the flood of 1893 and replacing the weakest of the old State levees of standard section. The new levees contain 1,433,218 cubic yards. During the same period 329,000 cubic yards have been placed in the levees by local authorities, principally by the Tensas Basin levee district of Louisiana, whose land is subject to overflow from the breaks in this line. With the allotments for the fiscal years ending June 30, 1895, and June 30, 1896, it is anticipated that the levees on the Mississippi front will be brought to standard grade throughout this district.

The local authorities on the Arkansas River have not kept pace with

the levee construction on the Mississippi River. Numerous crevasses occurred in their levee line in 1890, 1892, and 1893. For this reason, as well as on account of the increased flood heights in the Mississippi River in recent years, large volumes of water have flowed across the Amos Bayou ridge, inundating the country by flanking the levees on the Mississippi River. As existing levees are brought to standard grade it becomes of vital importance to prevent this inflow. During the past season the local levee boards, assisted by the Tensas Basin levee district of Louisiana and the Iron Mountain Railroad, have closed all crevasses above Red Fork and enlarged existing levees so that they have been able to resist this season a flood which attained a height of 24.8 feet at Little Rock.

It is proposed during the fiscal years ending June 30, 1895 and 1896, to continue the Arkansas River levees to a point 12 miles below Red Fork, to which they extended in 1882. To compensate for the rise in the flood heights of the Mississippi during recent years the Tensas Basin levee district has under contract the extension of the Amos Bayou levee along the Amos Bayou ridge a distance of 5 miles.

Levees, Middle Tensas district.—This levee district is on the right bank of the river and extends from the Louisiana State line to a point opposite Warrenton, 10 miles below Vicksburg. The length of its levee line is 87 miles.

During the past fiscal year the General Government has erected 673,634 cubic yards and the State organizations 1,052,000 cubic yards.

Surveys and observations.—Full surveys have been made during the year of all the works of channel improvement in this district and also of many levee lines. Discharge observations have been taken at Arkansas City and Wilsons Point.

For detail of operations in the third district see report of Capt. C. McD. Townsend, hereto appended. (Appendix 3.)

FOURTH DISTRICT (WARRENTON, MISS., TO HEAD OF PASSES, 484 MILES).

Natchez, Miss., and Vidalia, La., harbors, 700 miles below Cairo.—At a point about 5 miles north of Natchez the river strikes the line of high bluffs on the east bank and then makes a long bend to the west, returning again to the bluffs about a mile and a half above Natchez. It then follows the bluffs past Natchez and for some distance below, affording deep water and convenient landing places along the water front of Natchez and Vidalia, the town opposite. Both places are railroad terminals and have important river commerce. The distance by river around the bend referred to is about 13 miles. The distance across the neck is now less than a mile and is still diminishing by the caving of the bank above.

Should the river make a cut-off here its length would be shortened by 9 or 10 miles, and it is apprehended that the corresponding increase in slope and current in the river would result in rapidly cutting away on the Vidalia shore and a building out on the opposite side by the formation of a sand bank where the Natchez water front now is.

To effectively prevent this some 3 miles of bank revetment will be required above the neck to stop the erosion and prevent the gradual narrowing of the neck, and a levee is to be built along the axis of the neck to prevent the overflow and erosion across the neck and a sudden cutting through by the river during a flood.

Since appropriations have been insufficient to procure necessary plant and materials for the large amount of bank revetment required to carry

out the complete plan, operations have been confined to the spur levee. The final location and project for this work have been approved, but construction has not been begun.

The owner of the site required for the levee refused to allow the work to proceed without compensation for the land and consequent damages claimed, and demanded a larger sum than was considered reasonable in view of the benefit that would result to the property from the construction of the levee. Negotiations with the owner having failed, application was made to have the land condemned and proceedings for that purpose were begun and are pending.

New Orleans Harbor.—Work on this harbor, under the present project, was commenced in 1883. By the recommendation of a special board of engineers, a complete survey of the harbor was made in 1878–'79. The proceedings of this board are found in the Report of Chief of Engineers for 1878, p. 614.

In 1881, a Board of Engineer Officers was convened by the Secretary of War to prepare project for New Orleans Harbor. The report of this Board is contained in the Report of Chief of Engineers for 1882, p. 1359. The project therein presented was adopted by the Mississippi River Commission, September 17, 1882, with the recommendation in their report of December, 1882, that an appropriation be made and work commenced, which, for the time, should be confined to Carrollton Bend. The estimate for this part of the work was 10,000 linear feet, at $28 per foot. All subsequent appropriations have been made for and applied to the continuation of work under this project, with such modifications as were required by changing conditions, and are hereinafter described.

This project comprised, as its principal features, the prevention of the destruction of the wharves by the removal of the annual accumulation of sediment around and against the piles on which they are supported, and also the protection of the banks from the erosion of the current.

The first of these two objects has been undertaken by the city of New Orleans, and accomplished by directing, as the river falls, powerful artificial currents against the mass of deposit left by the previous flood.

The second of these objects—the protection of the bank from erosion—is of much greater magnitude, and of such description as can only be advantageously prosecuted by the General Government. Many parts of the river bank within the limits of the harbor are subject to such caving as is generally characteristic of the shores of the Mississippi River. Wherever this action occurs it is sufficiently disastrous, but within the limits of a harbor, on whose banks are collected the interests of a great city and the appliances for a great commerce, the loss and disaster which it occasions are vastly greater and more far reaching. It prevents the permanent construction and maintenance of the necessary facilities for receiving and delivering freight; it destroys the levees built to protect the city from inundation; it destroys paved streets, warehouses, and manufactories, and impairs all riparian values and the ease and safety of commerce.

The project adopted generally described the method of bank revetment, and recommended its immediate application to such part of the harbor bank as was at that time caving most rapidly, as far as the appropriation would permit. Accordingly, as above stated, work was commenced in 1883 in Carrollton Bend.

Before the completion of this part of the work, owing to limited and irregular appropriations, caving had encroached to such an extent on other important parts of the harbor that it became necessary to com-

mence work at three other points in the harbor, viz: Westwego, Goulds-boro, and the front of the Third Municipal district.

All these four detached parts of a general plan are now in good condition, and have secured such partial results as to establish the correctness of the proposed system for the complete improvement of the harbor. But as they are in an unfinished condition there is danger of damage to the ends of the work from caving, and the damage to the harbor and the city increases and extends.

Rectification of the Red and Atchafalaya rivers.—The extraordinary difficulties encountered in dealing with this problem have been described in prior reports, but the long delay which has taken place in the execution of the work and its present condition and necessities justify some special mention of the subject at this time. The project in course of execution contemplates:

1. The limitation of the discharge capacity of the Atchafalaya by sill dams near its head.

2. The deflection of the low-water discharge of Red River through upper Old River, north of Turnbulls Island, and a canal connecting upper Old River with the Mississippi River near Carrs Point—this deflection to be accomplished by means of a dam across Red River between the head of the Atchafalaya and the head of the upper Old River. The expected effect of this improvement, when completed, will be to make Red River a direct affluent of the Mississippi at ordinary and lower stages, and the Atchafalaya an affluent of the Mississippi at the same stages. The beds of both upper and lower Old Rivers will thus be subjected to the scouring effect of currents flowing constantly in one direction, and at times with a considerable velocity, in the place of the alternating and frequently very feeble currents now flowing through lower Old River.

Two of the projected sill dams across the head of the Atchafalaya were built in 1888 and 1889. They have been well maintained and have produced the effect expected from them. It was contemplated originally to build as many as six such dams across the Atchafalaya, if necessary, to securely restrict its discharge to a volume equal to the estimated high-water discharge of Red River, but no necessity has appeared so far for more than the two which are in place.

The dam across Red River to deflect its flow through upper Old River was begun during the season of 1888–'89, and carried during that season and the following to a point about 3 feet above low water, which was as high as it was thought practicable to go with that part of the plan in advance of the opening of a channel above Turnbulls Island. Early in December, 1890, dredging was begun in upper Old River, and continued until it was stopped by high water in February following. As soon as the water fell sufficiently the work was resumed, and it was continued until results demonstrated that it was impossible of performance with the dredging apparatus at the command of the Commission.

This difficulty arises from the peculiar character of the material found in the bed of upper Old River. It is a soft deposit of extremely fine composition, and under the action of a dredge dissolves and forms a semifluid mixture which requires for its successful handling machinery specially adapted to the work, especially in situations where the dredged material is to be deposited upon the land adjacent. It was expected that the dredging of upper Old River would be difficult, but was not anticipated that the apparatus which had operated with fair success in lower Old River would prove so totally unavailable in the channel above the island. The thorough trial made, however, demonstrated

the fact that nothing but a pumping dredge will do the work with economy and success.

The total amount of material which must be removed in order to make a good channel from the head of Turnbulls Island to Carrs Point will reach several million cubic yards. But it is expected to remove only enough of this by dredging to open a comparatively small channel between the points named, and to rely upon the scouring power of the water turned into that channel by the deflecting dam across Red River to accomplish the remaining and principal part of the work.

In the spring of 1892 the owners and officers of the boats engaged in trade upon the Atchafalaya, Red, and Ouachita rivers offered, with substantial unanimity, to submit to whatever interruption of commerce might ensue if the commission would make an effort to open the channel through upper Old River by scour alone, to be produced by raising the deflecting dam at once to the full height proposed, which is 10 feet above low water. But the Commission was of the opinion that an effort to open the upper channel without any aid by dredging was unlikely to succeed, and that it was wiser to defer the attempt until a dredge suitable for the work could be obtained.

With this view steps were taken to obtain such a dredge, and after careful investigation of the subject, plans and specifications were prepared and contract let. The dredge was received at Red River landing early in November last, and put at work for purposes of trial before acceptance in lower Old River. A number of alterations were found necessary, and it was not until the end of January that it was finally accepted from the builders. It was then taken to New Orleans and laid up for the winter. To attempt the opening of upper Old River during the season just past was impossible both on account of the late date at which the dredge was ready for use and the want of funds.

During these years no effort has been spared to keep the channel through lower Old River open by all available means, of which the chief has been persistent dredging. During the past season these efforts were so far successful that navigation was not at any time entirely interrupted. It is expected to use the new dredge upon this work during the coming low-water season, and it is hoped with more effective results than any heretofore attained.

It will be apparent from the foregoing résumé that the time has come for the final step in the execution of the plan proposed. To take it successfully requires that the completion of the deflecting dam and the opening of an incipient channel north of Turnbulls Island shall be effected simultaneously, or substantially so. To proceed with the work without funds in hand sufficient to accomplish with certainty the completion of the dam and prosecute the work of dredging in the upper channel with effect after it is once begun, with a surplus sufficient to do such additional work as might prove necessary during the following low-water season, would be to invite disaster of the most serious character. With all precautions that can be taken the degree of success which will be attained in the opening of the upper channel in a single season is uncertain, depending not only on the effect of scour upon the bed of upper Old River, but upon the relative stages of the Red and Mississippi during the season, both of which are uncertain. If these conditions should be favorable the newly-developed channel might have depth sufficient for navigation during the following low-water season with little or no assistance by dredging or otherwise, while if they should be unfavorable continuous and expensive work might be necessary to prevent the entire interruption of commerce.

It is the judgment of the Commission, therefore, that in order to proceed safely with the next step in the execution of the work proposed, and for which preparations are now complete, there ought to be available not less than $200,000. The balance unexpended May 31, 1894, was $41,401.52. Of this a considerable portion will probably be required to maintain navigation through lower Old River during the coming low-water season.

LEVEES.

Under the allotments for the several sublevee districts the work of repairs and renewals has been actively prosecuted. The percentage of the total length of the levee system in each district which has been replaced or rebuilt by the General Government during the past year, and the total percentage to date, are given in the following table:

Percentage of existing levee system built this year by the United States.

	Per cent.
Lower Tensas levee district	5
Atchafalaya levee district	8.8
Lafourche levee district	7.9
Pontchartrain levee district	18.6
Barataria levee district	7.3
Lake Borgne levee district	6.4
Percentage of total length of existing levee system, fourth district, Mississippi River, built by the United States this year	12.4

Percentage of length of existing levee system built to date by the United States.

	Per cent.
Lower Tensas levee district	52
Atchafalaya levee district	16.8
Lafourche levee district	14.4
Pontchartrain levee district	34.6
Barataria levee district	12.8
Lake Borgne levee district	10.2
Percentage of total length of existing levee system fourth district, Mississippi River, built by the United States	26.2

The high water of 1893 exceeded all previous records at points below Baton Rouge, and several crevasses occurred in the older embankments, but all new work withstood the strain.

Assistance was rendered as usual by the General Government in the work of maintaining the levees during the flood, and all crevasses were closed except the one at Rescue, 874 miles below Cairo on the east bank. The damage from this break was serious.

SURVEYS, GAUGES AND OBSERVATIONS.

The usual discharge observations were made at Carrollton, Red River Landing, and at Simmesport. At Carrollton and Red River Landing independent sets of observations were made on sections about 1 mile apart, to check if possible apparent discrepancies which have frequently been observed in the results heretofore obtained. Special surveys and observations were made referring to the possibility of limiting the flood height of the lower river, and the surveys in the vicinity of Sarpy and Belmont crevasses of 1892 were completed.

For details of operations in the fourth district see report of Capt. John Millis, hereto appended. (Appendix 4.)

CONSEQUENTIAL INJURIES BY INCREASED OVERFLOW IN UNPROTECTED AREAS.

The progressive extension of the levees upon the Lower Mississippi has given rise to some questions of private right to which the Commission desires to call the attention of Congress.

There are two classes of lands subject to overflow which will not receive protection from the levees so far built or projected by the Commission. One of these consists of the comparatively small areas lying between the river and the high land east of it and bounded by the irregular contours of the river channel and bluffs. These begin immediately below Cairo on the Kentucky side and extend the entire distance to Memphis. Beginning again at Vicksburg they continue to Baton Rouge. The river front bordered by them is about 450 miles in length. For the purpose of levee protection they would necessarily constitute a large number of independent districts, each to be treated separately. Some of these are capable of entire protection by levees. Others are so small that they can be protected only by complete closure without drainage outlets. An area so inclosed could be surface drained only by pumping, of which the expense would probably be prohibitory in most if not all the situations presented. To leave drainage outlets at the foot of such small areas, as is done in the case of the large ones, would let in backwater at flood stages, which would cover them completely or in large part.

The other class of unprotected areas includes the lands at the lower ends of the large alluvial basins, such as those immediately above the mouths of the Yazoo and Red rivers. The lower ends of these basins are of necessity left open for the escape of surface drainage and at flood stages the water backs up through those openings to a greater or less distance, according to the elevation of the river and slope of the land.

The legislature of Mississippi, by an act approved February 2, 1894, created a new levee district, named the Vicksburg levee district, extending from a point about 18 miles above Vicksburg to the Louisiana State line, distance of about 240 miles by the river. The district is divided by the act into four subdivisions, some of which would have to be further subdivided in order to protect them from overflow by levees. Provision is made by the act for the incorporation of the commissioners of the district, but no power of taxation or other means of raising money is conferred upon them.

It is said, and with probable truth, that it is impossible, in the present condition of the overflowed lands in the district to collect any tax for their protection. An urgent appeal has been made to the Commission by the board of commissioners of the levee district thus created to recommend an allotment of money from the appropriations made by Congress for the construction of levees in their district, with representations that the effect of the construction of levees elsewhere by the United States upon the recommendation of the Commission has been to increase flood heights along the front of their district and so subject the lands embraced within it to greater overflow than formerly occurred. This application has been indorsed by a large number of Senators and Representatives in Congress for whose wishes and opinions the Commission entertains the highest regard, and to which it is bound to accord great weight.

The commission is also advised of the pendency of a suit in the Court of Claims by the owners of a plantation within said district claiming damages for injury by overflow, said in the petition to have

been caused by levees constructed elsewhere by the United States under the recommendation of the Commission, and by the works of improvement begun and in progress at the mouth of Red River and head of the Atchafalaya. In the copy of the petition in said cause furnished to the Commission by the Department of Justice it is alleged that the omission of the United States to construct levees along the front of the lands of the petitioners constituted an adoption of the bluff behind the lands for the purposes of a levee and an appropriation of the petitioners' land for public use.

The object of the foregoing recital of facts is to present in a single view a situation which brings up some questions of difficulty and importance. It is not to be doubted that the immediate effect of the confinement of the flood discharge of the Mississippi by levees is to raise the high-water plane. But this increased elevation increases the scouring power of the current and may reasonably be expected to result after a time in an enlargement of the river channel and some consequent lowering of the flood level beneath the heights immediately following complete closure. But to what extent such lowering will take place and when, are questions not yet answered by experience, and upon which opinions differ.

The evidence is quite clear that the flood line in that part of the Mississippi lying below Red River has been raised by the progressive extension of the levees above, although not to a height proportional to the increased volume of discharge. The general effect above Red River is not so clearly defined, but it is probable that as far up as existing levees are effective to confine overflow they operate at present to increase the elevation reached by a flood of given volume, and will have that effect in increasing degree as the system approaches completion.

It must be recognized that the result will be to inflict some and perhaps great hardships upon the owners of lands in the unprotected areas described. Just how great the increase of burden cast upon those lands from this cause will be can not now be foreseen. They have always been liable to overflow by the highest floods, and they have always escaped overflow in some years. It is probable that this will continue to be true in the future as in the past. There may be, however, some floods which, unconfined, would not overflow them, but which, confined, will overflow them, and the injury in such case would doubtless be of that immediate and proximate character which constitutes recognized ground of legal redress.

But the subject is one which the Commission does not feel authorized to deal. In making recommendations for the expenditure of money in the construction of levees it has felt bound to make such application of it as would probably secure the largest aggregate of beneficial results. Some of the minor areas mentioned are large and valuable enough to warrant the expenditure of the money necessary to protect them by levees, while others are not. As to the former, the work is at present simply deferred to await the completion of other work which is considered more important. As to the latter, the construction of levees by the United States would seem to be an expenditure of money merely or mainly for the purpose of repairing a private wrong. This the Commission regards as beyond its jurisdiction.

When a case arises in which such injury has been done it will have to be ascertained upon whom the burden of its redress should fall. The injury will not be traceable to levees built by the United States any more than to those built by the States and local organizations. Neither

can it be attributed to the levees on any particular or limited portion of the river. It will be a result of the system as a whole. Manifestly, the Commission is not a suitable tribunal for the adjudication of such rights and equities. And to attempt to remedy such injuries by recommending the expenditure of money in the construction of levees which would not otherwise be built or worth the building would be, in the opinion of the Commission, an improper exercise of the powers conferred upon it by law.

The subject has been thus fully presented in order that Congress, with the facts before it, may take such action in respect thereto as shall in its wisdom seem best, and with the request that it may receive the early attention which its importance merits.

DREDGING.

The experimental dredging plant designed for use on the bars of the Mississippi at extreme low water for the temporary relief of commerce, pending the extension of work for the improvement of the channel, which was mentioned in the last report, has been completed. The delays incident to the designing and construction of machinery for the accomplishing of a kind of work not hitherto attempted on so great a scale prevented any trial of it during the last low water. It is now in readiness for use, and will be kept in operation during the present season as constantly as shall seem desirable either for experimental or practical working. Its estimated capacity is from 25,000 to 30,000 cubic yards per day of twenty-four hours.

The highest probability of success in the use of such a machine for the purposes here in view is to be found in making it of such proportions and construction that it can, within the shortest possible time, cut a channel through the entire length of a bar so that the current can take possession of the new path offered to it and maintain and enlarge it by scour before obstructing deposits are formed. The experimental dredge which has been built was designed with a view to such capacity and mode of operation as will enable it to cut rapidly and repeatedly through such bars as are usually found obstructing navigation in the Mississippi, and so provide quickly channels to be enlarged by following scour.

While the problem is still to be solved in its practical aspects by the test of actual trial, the importance of the end in view and of the early realization of results, if the method should prove successful, is so great that a second plant to embrace in its construction all points of improvement suggested by the experience gained in the construction of the first has been provided for, to be ready for use during the low-water season of the coming year.

Among the appendices will be found a paper by Capt. C. McD. Townsend on gauge relations, and a paper by Capt. John Millis on crevasses.

FINANCIAL STATEMENT.

Appropriation for salaries and expenses Mississippi River Commission:	
Balance on hand May 31, 1893	$138.26
Expended June 1, 1893, to May 31, 1894	138.26
Appropriation for survey of Mississippi River:	
Balance on hand May 31, 1893	7.08
Expended June 1, 1893, to May 31, 1894	7.08

Appropriation for improving Mississippi River:	
Balance on hand May 31, 1893	$802,903.26
Appropriated, act of March 3, 1893	2,665,000.00
Total	3,467,903.26
Expended, June 1, 1893, to May 31, 1894	2,797,835.64
Balance on hand May 31, 1894	670,067.62
Distributed as follows:	
Levees	130,445.92
Channel works	7,171.48
Harbors and bank protection	204,155.44
Red and Atchafalaya	43,298.79
Surveys, gauges, and observations	75,937.37
Plant, Mississippi River Commission, and miscellaneous	80,276.62
Unallotted	120,782.00
Total	670,067.62
Approximate outstanding liabilities and amounts covered by existing contracts	139,413.00

Estimate of funds by the Mississippi River Commission for the fiscal year ending June 30, 1896.

For improving Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commmission	$2,665,000
For improving harbors at—	
New Madrid, Mo	75,000
Memphis, Tenn	100,000
Greenville, Miss	200,000
Natchez, Miss., and Vidalia, La	300,000
New Orleans, La	300,000
For improvement at head of Atchafalaya and mouth of Red River, Louisiana	350,000

C. B. COMSTOCK,
Col. of Engrs. and Bvt. Brig. Gen.,
President Mississippi River Commission.
CHARLES R. SUTER,
Lieut. Col. of Engineers.
B. M. HARROD.
R. S. TAYLOR.
HENRY FLAD.
AMOS STICKNEY,
Lieut. Col. of Engineers.
HENRY L. WHITING,
U. S. Coast and Geodetic Survey.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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Secondary triangulation, Gordons Ferry to Prairie du Chien.
Gauge hydrographs, Carrollton and South Pass, 1877 to 1894.
Gauge hydrographs, Carrollton and South Pass, daily readings, 1891–'92.
Plotted results of discharge measurements at Columbus, New Madrid, Fulton, Helena, Arkansas City, Wilson Point, Red River, Simmsport, and Carrollton (9 sheets).
Plan of White River in vicinity of Clarendon.
Location of revetment, New Madrid front.
Survey of Plum Point Reach, November, 1893.
Location, sections, and details of Gold Dust Dam (9 sheets).
Mississippi River in vicinity of Memphis, Tenn.
Designs for fascine mattresses (3 sheets).
Location of levees, first and second districts, season of 1893–'94.
Map of third district showing area overflowed in 1893.
Levee profiles, Lower Yazoo and Upper and Middle Tensas (2 sheets).
Diagram of gauge relations between Cairo and Helena.
Designs of dredge *Ram* (3 plates).
Maps of levee subdistricts, fourth district (3 sheets).
Levee profiles, fourth district (6 sheets).
Map of fourth district, showing area overflowed in 1893.
Locations and diagrams, crevasse sections, fourth district.

APPENDIX 1.

REPORT OF FIRST LIEUT. GEO. A. ZINN, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

GENERAL: I have the honor to submit the following report of the operations of this office from May 31, 1893, to May 31, 1894. Capt. Carl F. Palfrey, at that time in charge, was relieved December 30, 1893, by First Lieut. J. G. Warren. The office was transferred to me May 10, 1894, in accordance with paragraph 1, Special Order 98, Headquarters of the Army, Adjutant-General's Office, Washington, D. C., April 26, 1894.

The work of the office has been carried on under allotments made by the Commission from the appropriation approved March 3, 1893, for improving the Mississippi River and from funds remaining from allotments of previous years. These allotments are as follows:

First. "Mississippi River Commission," applicable to salaries of civilian Commissioners, to expenses of offices of president and secretary, and to expenses of the meetings and inspections of the Commission. An allotment of $40,000 was made on May 7, 1893.

Second. "Surveys, gauges, and observations," applicable to the general survey of the river, to collection and office reduction of physical data and to general examinations and computations not confined to any one district. An allotment of $100,000 for these objects was made May 7, 1893.

MISSISSIPPI RIVER COMMISSION.

The Commission held two sessions during the year; one in New York, N. Y., June 26, 1893, and the other on board the steamer *Mississippi*, October 28 to November 8, 1893, from St. Louis, Mo., to New Orleans, La.

At the date of the last annual report the steamer *Mississippi* was undergoing repair and rebuilding. This work was completed and the boat used for the semiannual inspection in October, 1893. After this service she was laid up at Paducah, Ky., December 25, 1893, and remained there until May 23, 1894, when she was brought by a crew to St. Louis to be gotten ready for the meeting of the Commission set for June 23. Some minor repairs are still required, and the original design also contemplated a separate boiler for the steam-heating apparatus, for which the steam is at present drawn from the main boilers. The funds on hand are not sufficient to purchase this boiler.

SURVEYS, GAUGES, AND OBSERVATIONS.

The field work under this head comprised secondary triangulation, precise leveling, topography and hydrography, and gauge inspection.

Secondary triangulation and stone lines.—The party under Assistant Engineer A. T. Morrow continued the work northward from Dubuque, Iowa, to a base line near Prairie du Chien, Wis., a distance of 65 miles. Three base lines were measured and two nights azimuth work was done at each base. Twenty stone lines were established and 54 stones located from the triangulation stations.

Topography and hydrography.—This work was resumed August 2, 1893, by the party under Assistant Engineer Morrow at stone line 114 near Montrose, and closed September 30, at stone line 132, 1 mile above Keithsburg, Ill., a distance by river of 63 miles. The party completed 184 square miles of topography and 31 square miles of hydrography. This party then took up the work from the Head of the Passes and carried it northward to Donaldsonville, 175 miles, where it joined the work of 1882. This work included a portion of Cubitts Gap, the Jump, Lake Borgne Canal, the city of New Orleans, Lake Ponchartrain, from Milneburg to Manchac Pass, through the Pass to Lake Maurepas and along the south shore of Lake Maurepas to Amite River, and comprised 432 square miles of topography and 89 square miles of hydrography. The details of this work and of the secondary triangulation will be found in the reports of Assistant Engineers Ockerson and Morrow.

Precise levels.—A level party under W. S. Williams ran a line from the bench marks established by Assistant Engineer Jas. A. Paige, January 20, 1893, at the Head of the Passes to the light-house at the sea end of the East Jetty and connected with the tile and pipe bench marks set at intervals along the South Pass in February, 1893, by U. S. Assistant Engineer C. Donovan, with the water gauge at Port Eads and the bench marks pertaining to the jetty works.

Gauge inspection.—On the trip of the *Patrol* southward from St. Louis, each gauge was tested and repaired, gauge bulletins put in order, and the observer's notes examined. Lines of levels were run to nearest bench marks, and gauges reestablished at proper elevation. A high-water inspection was made on the trip up, the details of which are given in Mr. Ockerson's report, in which will also be found some notes on the mean Gulf level at Port Eads and the probable subsidence of the Mississippi delta.

The field parties are now in the office, reducing and platting their notes.

Manuscript charts, etc.—Detailed charts, scale 1:10000, 131 to 136, inclusive, from Quincy, Ill., to head of Des Moines Rapids, have been completed. Charts 137 to 141, inclusive, extending to Oquawka, Ill., have been projected and outlined. Chart 183, Head of Passes to Jump, has been inked.

Inch: mile maps, 110 to 115, inclusive, from Grafton, Ill., to Gregory, Mo., have been completed.

Upper Mississippi Valley map.—The Commission directed, November 7, 1893, that a map be prepared and published of the Mississippi River from Cairo to St. Paul similar to the Alluvial Valley map. This map has been projected on a scale of 1 inch to 5 miles from Cairo to Keithsburg, about 450 miles of river, and the details covered by the general survey between Cairo and Cap au Gris, 259 miles by river, have been reduced, transferred, and inked.

Published maps.—Detail charts, scale 1:20000, Nos. 117 to 130, inclusive, from mouth of the Missouri to Quincy, Ill., have been published. Sheets 131 to 136, inclusive, are in the hands of the printer, and satisfactory proofs have been received of sheets 131, 132, and 134.

Inch: mile maps, Nos. 101 to 113, inclusive, from Cairo, Ill., to Hannibal, Mo., have been published. Sheet 114 is in the hands of the printer.

Gauges.—The daily record of stages at 31 stations on the Mississippi River and 26 stations on the principal tributaries, except the Missouri, have been reduced, tabulated, and platted. The stages for the calendar year 1893 have been published and a table of highest and lowest readings has been prepared.

Discharges.—Discharge observations were taken at 8 stations on the main river and 3 tributaries and the results reduced and tabulated. Discharge observations at Clarendon, on the White River, and Little Rock, on the Arkansas River, were made in May, 1893.

These results, with the report of Mr. Kivas Tully, in charge of the computing division, are appended.

In connection with the gauge work, it would seem advisable to put everything of this nature on the Mississippi River under one head. The Mississippi River Commission has at present 16 gauges, and there are under charge of Capt. Willard a number of other gauges from St. Louis to New Orleans. On the upper river there are still others, under charge of Maj. Mackenzie. The records of these gauges are sent to this office for publication. The question of gauge inspection will now become one of importance because the *Patrol* will henceforth be occupied on the upper river on survey work, and to make these inspections will require either an extra boat or the use of the *Patrol* at considerable expense. If all the gauges on the Mississippi River were under control of this office it would more than justify the purchase of a small steamboat to take care of them.

A general summary of the present condition of the general survey which the Commission has been directed to make will be found in Mr. Ockerson's report.

The secondary triangulation is complete from the Head of the Passes to Prairie du Chien, Wis., 1,740 miles, a portion of it having been done by the U. S. Coast and Geodetic Survey prior to the organization of the Commission.

The precise leveling is completed from the outer end of East Jetty, South Pass, to St. Paul, Minn., 1,982 miles.

The field work of topography and hydrography has been completed from Head of Passes to Keithsburg, Ill., 1,515 miles.

The Alluvial Valley map, from Cairo to the Gulf, has been published.

The topographical map, scale 1 inch to 1 mile, of the river from Hannibal, Mo., to the Head of the Passes, has been published in 45 sheets—Nos. 1 to 32, and 101 to 113, inclusive.

The topographical and hydrographical map, scale 1:20000, of the river from Quincy, Ill., to Donaldsonville, La., has been published in 97 sheets—Nos. 3 to 69, and 100 to 130, inclusive, and index charts Nos. 1 and 2.

TONNAGE AND TRAFFIC.

The freight traffic on the Mississippi River between Cairo, Ill., and New Orleans, La., is carried on by steamboat and barge lines operating from St. Louis, Mo., Pittsburg, Pa., and Cincinnati, Ohio, for the through and way trade, and from Cairo, Memphis, Vicksburg, and New Orleans for the local trade.

The volume of freight originating north of Cairo is slightly less for 1893 than for the preceding year, due in part possibly to long-continued low water. The item of corn shows an increase.

The saving in carrying charges on wheat per bushel, between St. Louis, Mo., and Liverpool, via river and New Orleans, as against the rail route via New York, is shown in the tabulated statement below, taken from the published report of the St. Louis Merchants' Exchange for 1893:

Year.	Via New Orleans (average).	Via New York (average).
	Cents.	*Cents.*
1888	15¼	22.95
1889	17½	24.97
1890	14¼	21.48
1891	15⅝	23.55
1892	14	21
1893	14.71	21.72

The collection of accurate data regarding the actual tons of freight carried on the river between Cairo and New Orleans is difficult. Records kept by commercial boards are confined to the larger cities, and do not always particularize traffic to and from this part of the river, and the shipments between way points are not recorded.

The appended tabulated statement of traffic is as nearly correct as it is possible to make it without the employment of special agencies. Where only partial information could be obtained, estimated figures have been used, which are below rather than above the actual quantities:

Statement of tonnage and traffic on the Mississippi River between the mouth of the Ohio and New Orleans, La., for 1893.

Initial points.	Steamers.	Barges.	Total approximate tonnage.	Tons shipped and received.
St. Louis, Mo	24	85	110,600	564,650
Pittsburg, Pa	17	1,160	580,000	1,100,000
Cincinnati, Ohio	8	5	10,000	53,714
Cairo, Ill	6	15	6,300	*45,000
Memphis, Tenn	15	.....	10,195	139,400
Vicksburg, Miss	3	.....	1,800	*21,000
New Orleans, La	48	13	7,786	*192,500
Way trade and miscellaneous	.....	.....	.....	*150,000
Total	121	1,278	726,681	2,266,264

* Estimated.

Financial statements for May, detailed and consolidated statements to May 31, 1894, statement of maps issued, list of civilian engineers, and approximate value of plant, are appended.

Very respectfully, your obedient servant,

GEO. A. ZINN,
First Lieut., Corps of Engineers,
Secretary Mississippi River Commission.

Gen. C. B. COMSTOCK, U. S. A.,
President Mississippi River Commission.

Financial statements for the month ending May 31, 1894.

SECRETARY'S OFFICE.

	Mississippi River Commission, act Oct. 2, 1888.	Survey of Mississippi River, act Aug. 11, 1888.	Improving Mississippi River: surveys, gauges, and observations.	Improving Mississippi River: Mississippi River Commission.	Improving Mississippi River: rebuilding steamer Mississippi.	Total.
Balance unexpended at end of last fiscal year	$138.26	$7.08	$24,689.92	$7,407.21	$23,692.86	$55,935.33
Appropriated and allotted during current fiscal year	.....	.....	100,000.00	40,000.00	.....	140,000.00
Gained by transfer during current fiscal year	.....	.....	.....	.....	10,000.00	10,000.00
Lost by transfer during current fiscal year	.....	.....	.....	10,000.00	.....	10,000.00
Total available	138.26	7.08	124,689.92	37,407.21	33,692.86	195,935.33
Expended during current fiscal year	138.26	7.08	66,163.27	28,271.84	33,692.74	128,273.19
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....
Total disposed of	138.26	7.08	66,163.27	28,271.84	33,692.74	128,273.19
Balance unexpended	.....	.....	58,526.65	9,135.37	.12	67,662.14
In treasury	.....	.....	56,577.27	7,995.97	.....	64,573.24
On hand	.....	.....	1,949.38	1,139.40	.12	3,088.90
Overdrawn	.....	.....	.....	.....	.....	.....
Balance as above	.....	.....	58,526.65	9,135.37	.12	67,662.14
Outstanding liabilities (estimated)	.....	.....	3,700.00	3,050.00	.12	6,750.12
Amounts covered by existing contracts	.....	.....	.....	.....	.....	.....
Total liabilities	.....	.....	3,700.00	3,050.00	.12	6,750.12
Balance available	.....	.....	54,826.65	6,085.37	.....	60,912.02

WORKS ABOVE CAIRO, ACT JULY 5, 1884.

Balance unexpended at end of last fiscal year	$8,600.00
July 1, 1894, outstanding liabilities	39.00
July 1, 1894, balance available	8,561.00

FIRST AND SECOND DISTRICTS.

	Plum Point Reach.	Plant, first and second districts.	Hickman, Ky.	New Madrid, Mo.	Improving harbor at New Madrid, Mo.	Preservation of works.
Balance unexpended at end of last fiscal year	$33,111.75	$10,014.51	$41,797.85	$18.61	$18,429.27	$7,725.71
Appropriated and allotted during current fiscal year	305,000.00	179,000.00	.....	.....	.....	.....
Gained by transfer during current fiscal year	*25,000,21	1.00	.....	.....	.08	.....
Lost by transfer during current fiscal year	.....	.....	.....	.....	.....	.....
Total available	363,111.96	189,015.51	41,797.85	18.61	18,429.35	7,725.71
Expended during current fiscal year	362,494.57	168,980.13	.....	.....	18,428.95	3,959.45
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....
Total disposed of	362,494.57	168,980.13	.....	.....	18,428.95	3,959.45
Balance unexpended	617.39	20,035.38	41,797.85	18.61	.40	3,766.26
In treasury	.....	19,000.00	31,843.17	.....	.....	5,000.00
On hand	617.39	1,035.38	9,954.68	18.61	.40	.....
Overdrawn	.....	.....	.....	.....	.....	1,233.74
Balance as above	617.39	20,035.38	41,797.85	18.61	.40	3,766.26
Outstanding liabilities	617.39	18,000.00	.....	18.61	.40	500.00
Covered by existing contracts	.....	.....	.....	.....	.....	.....
Total liabilities	617.39	18,000.00	.....	18.61	.40	500.00
Balance available	.....	2,035.38	41,797.85	.....	.....	3,266.26

*21 cents refunded May —, 1894, on account of overpayment.

Financial statements for the month ending May 31, 1894—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Surveys, gauges, and observations.	Dredging experiments.	Hopefield Bend.	Improving harbor at Memphis, Tenn.	Removal Nonconnah Rock.	Helena, Ark.
Balance unexpended at end of last fiscal year	$368.26	$40,257.06	$84.67	$25,000.00	$5,952.25	$1,496.10
Appropriated and allotted during current fiscal year	8,000.00	50,000.00	100,000.00			
Gained by transfer during current fiscal year		1.98				
Lost by transfer during current fiscal year			25,000.00			
Total available	8,368.26	90,259.04	75,084.67	25,000.00	5,952.25	1,496.10
Expended during current fiscal year	7,079.17	74,665.61	75,021.72	24,999.58	798.98	
Refunded during current fiscal year						
Total disposed of	7,079.17	74,665.61	75,021.72	24,999.58	798.98	
Balance unexpended	1,289.09	15,593.43	62.95	.42	5,153.27	1,496.10
In treasury	3,000.00	10,000.00				500.00
On hand		5,593.43	62.95	.42	5,153.27	996.10
Overdrawn	1,710.91					
Balance as above	1,289.09	15,593.43	62.95	.42	5,153.27	1,496.10
Outstanding liabilities	800.00	3,000.00	62.95	.42		
Covered by existing contracts					5,153.27	
Total liabilities	800.00	3,000.00	62.95	.42	5,153.27	
Balance available	489.09	12,593.43				1,496.10

	Upper Yazoo levee district.	Upper White River levee district.	Lower White River levee district.	Lower St. Francis levee district.	Examinations, surveys, and contingencies.	Total.
Balance unexpended at end of last fiscal year	$5,060.67	$26,661.94	$8,108.02			$224,086.67
Appropriated and allotted during current fiscal year	100,000.00	53,000.00	75,000.00	$88,000.00	$218.00	958,218.00
Gained by transfer during current fiscal year						25,003.27
Lost by transfer during current fiscal year						25,000.00
Total available	105,060.67	79,661.94	83,108.02	88,000.00	218.00	1,182,307.94
Expended during current fiscal year	94,449.19	70,925.04	75,656.99	73,300.07	218.00	1,050,977.45
Refunded during current fiscal year						
Total disposed of	94,449.19	70,925.04	75,656.99	73,300.07	218.00	1,050,977.45
Balance unexpended	10,611.48	8,736.90	7,451.03	14,699.93		131,330.49
In treasury	10,000.00	3,000.00	10,000.00	10,000.00		102,343.17
On hand	611.48	5,736.90		4,699.93		34,480.94
Overdrawn			2,548.97			5,493.62
Balance as above	10,611.48	8,736.90	7,451.03	14,699.93		131,330.49
Outstanding liabilities	1,500.00	1,000.00	1,000.00	500.00		26,999.77
Covered by existing contracts				6,665.00		11,818.27
Total liabilities	1,500.00	1,000.00	1,000.00	7,165.00		38,818.04
Balance available	9,111.48	7,736.90	6,451.03	7,534.93		92,512.45

Financial statements for the month ending May 31, 1894—Continued.

THIRD DISTRICT.

	Lake Providence Reach.	Plant, third district.	Surveys, gauges, and observations.	Lower Yazoo levee district.	Upper Tensas levee district.	Middle Tensas levee district.	Vicksburg, Miss.
Balance unexpended at end of last fiscal year	$8,837.45	$4,434.18	$256.30	$19,721.91	$4,148.46	$12,833.43	$6,039.62
Appropriated and allotted during current fiscal year	10,000.00	.....	12,000.00	150,000.00	300,000.00	100,000.00	.....
Gained by transfer during current fiscal year	.....	.....	.....	.....	.....	5,000.00	.....
Lost by transfer during current fiscal year	.....	.....	.....	.....	5,000.00	.....	.....
Total available	18,837.45	4,434.18	12,256.30	169,721.91	299,148.46	117,833.43	6,039.62
Expended during current fiscal year	12,283.36	4,434.18	6,965.47	156,937.14	285,971.14	116,665.02	5,931.55
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....	.....
Total disposed of	12,283.36	4,434.18	6,965.47	156,937.14	285,971.14	116,665.02	5,931.55
Balance unexpended	6,554.09	.....	5,290.83	12,784.77	13,177.32	1,168.41	108.07
In treasury	.....	.....	5,000.00	.....	10,000.00	.....	.....
On hand	6,554.09	.....	290.83	12,784.77	3,177.32	1,168.41	108.07
Overdrawn	.....	.....	.....	.....	.....	.....	.....
Balance as above	6,554.09	.....	5,290.83	12,784.77	13,177.32	1,168.41	108.07
Outstanding liabilities	.....	.....	800.00	600.00	1,000.00	600.00	1.10
Amounts covered by existing contracts	931.33	.....	.....	.....	.....	.....	106.97
Total liabilities	931.33	.....	800.00	600.00	1,000.00	600.00	108.07
Balance available	5,622.76	.....	4,490.83	12,184.77	12,177.32	568.41	.....

	Lake Bolivar front.	Ashbrook Neck.	Improving harbor at Vicksburg, Miss.	Improving harbor at Greenville, Miss.	Plant.	Stone.	Totals.
Balance unexpended at end of last fiscal year	$2,622.80	$22.37	$42,483.01	$5,241.54	.....	.....	$106,641.07
Appropriated and allotted during current fiscal year	15,000.00	.....	.....	.....	$113,000.00	$100,000.00	800,000.00
Gained by transfer during current fiscal year	.....	.....	.....	.....	.....	.....	5,000.00
Lost by transfer during current fiscal year	.....	.....	.....	.....	.....	.....	5,000.00
Total available	17,622.80	22.37	42,483.01	5,241.54	113,000.00	100,000.00	906,641.07
Expended during current fiscal year	17,518.42	22.37	31,429.27	2,991.88	82,640.95	42,824.19	766,614.94
Refunded during current fiscal year	.....	.....	.....	.....	.....	.....	.....
Total disposed of	17,518.42	22.37	31,429.27	2,991.88	82,640.95	42,824.19	766,614.94
Balance unexpended	104.38	.....	11,053.74	2,249.66	30,359.05	57,175.81	140,026.13
In treasury	.....	.....	.....	.....	40,000.00	80,000.00	135,000.00
On hand	104.38	.....	11,053.74	2,249.66	.....	.....	37,491.27
Overdrawn	.....	.....	.....	.....	9,640.95	22,824.19	32,465.14
Balance as above	104.38	.....	11,053.74	2,249.66	30,359.05	57,175.81	140,026.13
Outstanding liabilities	7.31	.....	.....	.....	5,000.00	.....	8,008.41
Amounts covered by existing contracts	97.07	.....	.....	76.16	21,200.00	57,175.81	79,587.34
Total liabilities	104.38	.....	.....	76.16	26,200.00	57,175.81	87,595.75
Balance available	.....	.....	11,053.74	2,173.50	4,159.05	.....	52,430.38

Financial statements for the month ending May 31, 1894—Continued

FOURTH DISTRICT.

	Lower Tensas levee district.	Atchafalaya levee district.	Lafourche levee district.	Pontchartrain levee district.	Barataria levee district.	Lake Borgne levee district.
Balance unexpended at end of last fiscal year	$12,626.48	$25,344.19	$2,698.12	$7,551.72	$126.17	$118.56
Appropriated and allotted during current fiscal year	132,000.00	152,000.00	90,000.00	150,000.00	60,000.00	50,000.00
Gained by transfer during current fiscal year						
Lost by transfer during current fiscal year						
Total available	144,626.48	177,344.19	92,698.12	157,551.72	60,126.17	50,118.56
Expended during current fiscal year	*123,405.60	162,717.58	†81,125.52	‡155,269.69	§47,771.19	‖42,359.58
Refunded during current fiscal year						
Total disposed of	123,405.60	162,717.58	81,125.52	155,269.69	47,771.19	42,359.58
Balance unexpended	21,220.88	14,626.61	11,572.60	2,282.03	12,354.98	7,758.98
In treasury	24,876.70	20,000.00			¶4,915.40	
On hand			11,572.60	2,282.03	7,439.58	7,758.98
Overdrawn	3,655.82	5,373.39				
Balance as above	21,220.88	14,626.61	11,572.60	2,282.03	12,354.98	7,758.98
Outstanding liabilities	733.11	161.22	80.21	120.47	34.67	26.67
Amounts covered by existing contracts						3,066.45
Total liabilities	733.11	161.22	80.21	120.47	34.67	3,093.12
Balance available	20,487.77	14,465.39	11,492.39	2,161.56	12,320.31	4,665.86

	Red and Atchafalaya rivers.	Surveys, gauges, and observations.	Improving Mississippi River.	Improving Atchafalaya and Red rivers, La.	Improving harbors at Natchez and Vidalia, Miss. and La.	Total.
Balance unexpended at end of last fiscal year	$57,662.60	$5,855.96	$111,983.80	$80,000.00	$78,121.29	$270,105.09
Appropriated and allotted during current fiscal year		12,000.00	646,000.00			646,000.00
Gained by transfer during current fiscal year						
Lost by transfer during current fiscal year						
Total available	57,662.60	17,855.96	757,983.80	80,000.00	78,121.29	916,105.09
Expended during current fiscal year	57,662.60	7,025.16	677,336.92	36,701.21	400.10	714,438.23
Refunded during current fiscal year						
Total disposed of	57,662.60	7,025.16	677,336.92	36,701.21	400.10	714,438.23
Balance unexpended		10,830.80	80,646.88	43,298.79	77,721.19	201,666.86
In treasury		9,000.00	58,792.10	40,000.00	75,000.00	173,792.10
On hand		1,830.80	30,883.99	3,298.79	2,721.19	36,903.97
Overdrawn			9,029.21			9,029.21
Balance as above		10,830.80	80,646.88	43,298.79	77,721.19	201,666.86
Outstanding liabilities		36.74	1,193.09	1,897.27	53.29	3,143.65
Amounts covered by existing contracts			3,066.45			3,066.45
Total liabilities		36.74	4,259.54	1,897.27	53.29	6,210.10
Balance available		10,794.06	76,387.34	41,401.52	77,667.90	195,456.76

*$123.30. †$137.70. ‡$161.10. §$84.60. ‖$175.05, Treasury settlements.

Detailed statement, March 3, 1881, to May 31, 1894 (current allotments).

	Appropriations and allotments.	Applied by general service.	Total available.	Expended.	Total balances.
Protection near Cairo	$50,000.00		$50,000.00	$41,400.00	$8,600.00
Total above Cairo	50,000.00		50,000.00	41,400.00	8,600.00
FIRST AND SECOND DISTRICTS.					
Plum Point Reach	3,644,821.18	$364,515.50	4,009,336.68	[1]4,008,719.29	617.39
Plant, first and second districts	369,507.35	5,017.40	374,524.75	[2]354,489.37	20,035.38
Hickman, Ky	85,843.17	3,288.83	89,132.00	47,334.15	41,797.85
New Madrid, Mo	1,000.00		1,000.00	981.39	18.61
Improving harbor at New Madrid, Mo	25,000.00		25,000.00	[3]24,999.60	.40
Preservation of works, first and second districts	20,680.42	3,187.47	23,867.89	20,101.63	3,766.26
Surveys, gauges, and observations	28,479.03		28,479.03	27,189.94	1,289.09
Dredging experiments	100,000.00		100,000.00	[4]84,406.57	15,593.43
Hopefield Bend	173,431.78		173,431.78	173,368.83	62.95
Improving harbor, Memphis, Tenn	25,000.00		25,000.00	24,999.58	.42
Removal of Nonconnah Rock	6,000.00		6,000.00	846.73	5,153.27
Helena, Ark	66,106.83	10,393.17	76,500.00	75,003.90	1,496.10
Upper Yazoo levee district	204,548.65		204,548.65	193,937.17	10,611.48
Upper White River levee district	103,790.39		103,790.39	95,053.49	8,736.90
Lower White River levee district	150,000.00		150,000.00	142,548.97	7,451.03
Lower St. Francis levee district	88,000.00		88,000.00	73,300.07	14,699.93
Examinations, surveys, and contingencies	218.00		218.00	218.00	
Total	5,092,426.80	386,402.37	5,478,829.17	5,347,498.68	131,330.49
THIRD DISTRICT.					
Lake Providence Reach	2,985,876.34	255,046.96	3,240,923.30	3,234,369.21	6,554.09
Vicksburg, Miss	366,968.70	2,662.27	369,630.97	369,522.90	108.07
Lake Bolivar Front	21,000.00		21,000.00	20,895.62	104.38
Ashbrook Neck	317,000.00	49,003.87	366,003.87	366,003.87	
Plant, third district	231,331.17	17,095.54	248,426.71	248,426.71	
Surveys, gauges, and observations	34,138.90		34,138.90	28,848.07	5,290.83
Lower Yazoo levee district	354,091.01		354,091.01	341,306.24	12,784.77
Upper Tensas levee district	608,854.12		608,854.12	595,676.80	13,177.32
Middle Tensas levee district	215,277.47		215,277.47	214,109.06	1,168.41
Improving harbor, Vicksburg, Miss	80,000.00		80,000.00	68,946.26	11,053.74
Improving harbor, Greenville, Miss	100,000.00		100,000.00	97,750.34	2,249.66
Plant	113,000.00		113,000.00	82,640.95	30,359.05
Stone	100,000.00		100,000.00	42,824.19	57,175.81
Total	5,527,537.71	323,808.64	5,851,346.35	5,711,320.22	140,026.13
FOURTH DISTRICT.					
Lower Tensas levee district	282,000.00		282,000.00	[5]260,779.12	21,220.88
Atchafalaya levee district	307,000.00		307,000.00	292,373.39	14,626.61
Lafourche levee district	180,000.00		180,000.00	[6]168,427.40	11,572.60
Barataria levee district	120,000.00		120,000.00	[7]107,645.02	12,354.98
Pontchartrain levee district	300,000.00		300,000.00	[8]297,717.97	2,282.03
Lake Borgne levee district	100,000.00		100,000.00	[9]92,241.02	7,758.98
Red and Atchafalaya rivers	657,500.00		657,500.00	657,500.00	
Surveys, gauges, and observations	37,121.89		37,121.89	26,291.09	10,830.80
Improving Atchafalaya and Red rivers, Louisiana	80,000.00		80,000.00	36,701.21	43,298.79
Improving harbor, Natchez and Vidalia	80,000.00		80,000.00	2,278.81	77,721.19
Total	2,143,621.89		2,143,621.89	1,941,955.03	201,666.86
Mississippi River Commission	105,000.00		105,000.00	[10]95,864.63	9,135.37
Surveys, gauges, and observations	298,345.33		298,345.33	[11]239,818.68	58,526.65
Rebuilding steamer Mississippi	35,000.00		35,000.00	34,999.88	.12
Total Secretary's office	438,345.33		438,345.33	370,683.19	67,662.14
Unallotted	120,782.00		120,782.00		120,782.00
Grand total	13,372,713.73	710,211.01	14,082,924.74	13,412,857.12	670,067.62

[1] 21 cents refunded May, 1894.
[2] $1 refunded January 8, 1894.
[3] 8 cents refunded January 8, 1894.
[4] $1.98 refunded January 17, 1894.
[5] Includes $123.30 disbursed by Treasury settlement.
[6] Includes $137.70 disbursed by Treasury settlement.
[7] Includes $84.60 disbursed by Treasury settlement.
[8] Includes $161.10 disbursed by Treasury settlement.
[9] Includes $175.05 disbursed by Treasury settlement.
[10] Includes $4.03 disbursed by Treasury settlement No. 7130.
[11] Includes $61.55 disbursed by Treasury settlement No. 7977.

Consolidated statement of all appropriations expended under the Mississippi River Commission, May 31, 1894.

Act of—		
June 28, 1879		$175,000.00
June 16, 1880		150,000.00
March 3, 1881		1,000,000.00
March 3, 1881		150,000.00
August 2, 1882		4,123,000.00
August 7, 1882		150,000.00
March 3, 1883		150,000.00
January 19, 1884		1,000,000.00
July 5, 1884		75,000.00
July 5, 1884, less $5,000 transferred to snag-boat service		2,065,000.00
July 7, 1884		75,000.40
August 5, 1886, less $5,942.60 for expenses office Chief of Engineers		1,994,057.40
August 5, 1886, less $47.30 for expenses office Chief of Engineers		29,952.70
August 11, 1888, less 4,859 for expenses office Chief of Engineers		2,840,141.00
August 11, 1888		75,000.00
October 2, 1888		35,000.00
October 19, 1888, less $4,214.39 reverted to the Treasury		20,785.61
September 19, 1890		3,200,000.00
September 30, 1890		5,625.00
March 3, 1891		1,000,000.00
July 13, 1892		2,470,000.00
March 3, 1893		2,665,000.00
Total specific appropriations		23,448,561.71
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42, reverted to Treasury	$272,504.96	
Same for works above Cairo, under act of July 5, 1884	22,632.53	
Total balances		295,137.49
Total available		23,743,699.20
Expended:		
Plum Point Reach		4,120,547.98
Memphis Harbor and Reach		1,286,087.67
Lake Providence		3,247,058.51
Red and Atchafalaya		823,418.61
Surveys, gauges, and observations		1,097,566.05
Mississippi River Commission		366,980.45
Levees		7,646,716.56
Other works		4,485,255.75
		23,073,631.58
Balance May 31, 1894		670,067.62
		23,743,699.20

Statement of charts issued from May 31, 1893, to May 31, 1894.

Description.	Free.	Sold.	Total.
Alluvial valley below Cairo	104	180	284
Scale 1:20,000	2,435	251	2,686
Scale inch:mile	815	354	1,169
Total	3,354	785	4,139
Proceeds deposited with the Assistant Treasurer of the United States at St. Louis, Mo			$78.90

List of civilian engineers employed on works under the Mississippi River Commission in charge of First Lieut. George A. Zinn, Corps of Engineers, from May 31, 1893, to May 31, 1894.

Name and residence.	Time employed.	Pay per month.	Where employed.	Work on which employed.
	Months.			
J. A. Ockerson, St. Louis, Mo.	12	$250	In field and in St. Louis office.	In charge surveys, S. G. and O.
A. T. Morrow, Rockford, Ill	12	175	....do	Surveys and reduction of field work, S. G. and O.
Kivas Tully, St. Louis, Mo	12	175	St. Louis	In charge of computing division, S. G. and O.
C. W. Clark, St. Louis, Mo	12	175	....do	Platting maps, S. G. and O.
W. G. Comber, St. Louis, Mo	12	150	In field and in St. Louis office.	Surveys and reduction of field work, S. G. and O.

Approximate value of plant belonging to the United States, used on works under the Mississippi River Commission, in charge of First Lieut. George A. Zinn, Corps of Engineers.

Allotment.	Class of property.	No.	Approximate value May 31, 1894.
Mississippi River Commission.....	Steamboat Mississippi, with outfit.....	1	$60,000
	Rowboats	4	200
	Books and furniture	....	250
	Steamboat Patrol, with outfit.....	1	10,000
	Survey boat Illinois, with outfit	1	1,000
Surveys, gauges, and observations.	Rowboats.....	11	120
	Surveying instruments.....	....	8,000
	Drawing instruments.....	....	500
	General tools.....	....	450
	Printing plant	....	700
	Office furniture	....	750

LIST OF APPENDIXES ACCOMPANYING THE REPORT OF THE SECRETARY OF THE MISSISSIPPI RIVER COMMISSION.

A.—Report of Assistant Engineer J. A. Ockerson on the field work and office reductions.
B.—Report of Assistant Engineer A. T. Morrow on secondary triangulation field work from Gordons Ferry, Iowa, to Prairie du Chien, Wis.
C.—Report of Assistant Engineer A. T. Morrow on topographical and hydrographical field work from near Montrose, Iowa, to Keithsburg, Ill.
D.—Report of Assistant Engineer A. T. Morrow on topographical and hydrographical field work from Head of Passes, Louisiana, to Donaldsonville, La.
E.—Tables of highest and lowest stages since 1872.
F.—Field reports of discharge measurements and report of Assistant Engineer Kivas Tully on the reduction of discharge observations, with tabulated results of same and plates showing results graphically.
Also results of discharge observations made in 1879 for the "Low-water board."

LIST OF PLATES ACCOMPANYING THE SECRETARY'S REPORT.

1. Secondary triangulation Gordons Ferry to Prairie du Chien.
2. Hydrographs of gauges at Carrollton, La., and South Pass Light-House for the years 1877 to 1894.
3. Hydrographs of gauges at Carrollton, La., and South Pass Light-House, showing daily readings from September 8, 1891, to October 19, 1892.
4. Platted results of discharge measurements at Columbus, Ky.
5. Platted results of discharge measurements at New Madrid, Mo.
6. Platted results of discharge measurements at Fulton, Tenn.
7. Platted results of discharge measurements at Helena, Ark.
8. Platted results of discharge measurements at Arkansas City, Ark.
9. Platted results of discharge measurements at Wilsons Point, La.
10. Platted results of discharge measurements at Red River Landing, La.
11. Platted results of discharge measurements at Simmsport, La.
12. Platted results of discharge measurements at Carrollton, La.
13. Plan of White River in vicinity of Clarendon.

APPENDIX 1 A.

REPORT OF ASSISTANT ENGINEER J. A. OCKERSON ON THE FIELD WORK AND OFFICE REDUCTION.

ST. LOUIS, MO., *June 1, 1894.*

SIR: I have the honor to submit the following report on the field work and office reductions for the year May 31, 1893, to May 31, 1894:

The work has been carried on by practically the same force as was employed during the preceding year, and the same plant was used. The field work was carried

northward during the summer, and during the winter the survey between the Head of Passes and Donaldsonville was completed.

The details of the different classes of work and the tabulated results will be found under their proper headings, as follows:

SECONDARY TRIANGULATION AND STONE LINES.

The secondary triangulation on the date of the last annual report had been completed to the vicinity of Dubuque, Iowa. The party under Assistant Engineer A. T. Morrow was quartered on the steamer *Patrol*. Work was continued up the river and closed on a base line at Prairie du Chien, Wis., on July 25.

The distance, by river, covered by the triangulation and stone lines was about 65 miles. Three base lines were measured and two nights' azimuth work was done at each base.

Twenty stone lines were established and fifty-four stones on them located from the triangulation stations.

Fifty-six triangles were closed, with an average error of closure of 1.86 seconds. The average closure of thirty triangles was 1.90 seconds small and twenty-six triangles averaged 1.80 seconds large.

The discrepancies at the measured base lines are shown in the following table:

TABLE No. 1.

Location of base line.	Number of triangles between bases.	Discrepancies between first and second measurements of base lines.	Discrepancies between observed length and computed length of base before adjustment.	Discrepancies between first and second night's azimuth observations.	Discrepancies between observed and computed azimuth before adjustment.
				Seconds.	*Seconds.*
East Dubuque, Ill	45	1 in 346,926	1 in 14,437	1.77	7.64
Casaville, Wis	22	1 in 249,010	1 in 84,012	1.36	3.31
Prairie du Chien, Wis	23	1 in 242,665	1 in 33,313	2.04	.52

The methods pursued in this work are set forth in the instructions for triangulation work, Annual Report, 1891, pp. 3475–3476.

The angles were read with Troughton & Simms 10-inch theodolities, reading with micrometer to single second.

The base lines were measured with steel tape (Missouri River Commission, No. II), 300 feet long, supported at intervals of 30 feet and with a tension of 16 pounds.

The following table, No. 2, gives the corrections for inclination of tape for differences of 0.01 of a foot in elevation of extremities of tape.

Table No. 3 gives the corrections to the normal tape length for temperatures differing from the normal temperature of tape, which is 62° F.

Table No. 4 gives the geographical positions of the triangulation stations, stone line, bench marks and prominent buildings.

A sketch of the triangulation and stone lines and detailed descriptions of their locations are appended.

At Galena the astronomical post of the United States Lake Survey, 1873, was connected with and the following comparison derived: United StatesLake Survey, latitude 42° 25′ 09.50″; longitude 90° 25′ 52.05″. Triangulation of the Mississippi River Commission, coordinates derived from Cairo, Ill. Astronomical station, latitude 42° 25′ 09.43″, longitude 90° 25′ 55.56″. Discrepancy in latitude, 0.07 seconds. Discrepancy in longitude, 3.51 seconds.

For details of season's work see report of Assistant Engineer A. T. Morrow, Appendix 1 B.

TABLE 2.—*Corrections for inclination of tape 300 feet long.*

[For the differences in elevation of ends of tape shown in following table h = the difference in elevation of ends of tape in feet.]

h	Correction.	h	Correction.	h	Correction.	h	Correction.	h	Correction.	h	Correction.	h	Correction.	h	Correction.
0.00	0.0000000	0.25	0.0001042	0.50	0.0004167	0.75	0.0009375	1.00	0.0016667	1.25	0.0026042	1.50	0.0037500	1.75	0.0051042
.01	.0000002	.26	.0001127	.51	.0004335	.76	.0009627	.01	.0017002	.26	.0026460	.51	.0038002	.76	.0051627
.02	.0000007	.27	.0001215	.52	.0004507	.77	.0009882	.02	.0017340	.27	.0026882	.52	.0038507	.77	.0052215
.03	.0000015	.28	.0001307	.53	.0004682	.78	.0010140	.03	.0017682	.28	.0027307	.53	.0039015	.78	.0052807
.04	.0000027	.29	.0001402	.54	.0004860	.79	.0010402	.04	.0018027	.29	.0027735	.54	.0039527	.79	.0053402
.05	.0000042	.30	.0001500	.55	.0005042	.80	.0010667	.05	.0018375	.30	.0028167	.55	.0040042	.80	.0054000
.06	.0000060	.31	.0001602	.56	.0005227	.81	.0010935	.06	.0018727	.31	.0028602	.56	.0040560	.81	.0054602
.07	.0000082	.32	.0001707	.57	.0005415	.82	.0011207	.07	.0019082	.32	.0029040	.57	.0041082	.83	.0055207
.08	.0000107	.33	.0001815	.58	.0005607	.83	.0011482	.08	.0019440	.33	.0029482	.58	.0041607	.83	.0055816
.09	.0000135	.34	.0001927	.59	.0005802	.84	.0011760	.09	.0019802	.34	.0029927	.59	.0042135	.84	.0056427
.10	.0000167	.35	.0002042	.60	.0006000	.85	.0012042	.10	.0020167	.35	.0030375	.60	.0042667	.85	.0057042
.11	.0000202	.36	.0002160	.61	.0006202	.86	.0012327	.11	.0020535	.36	.0030827	.61	.0043202	.86	.0057661
.12	.0000240	.37	.0002282	.62	.0006407	.87	.0012615	.12	.0020907	.37	.0031282	.62	.0043740	.87	.0058282
.13	.0000282	.38	.0002407	.63	.0006615	.88	.0012907	.13	.0021282	.38	.0031740	.63	.0044282	.88	.0058907
.14	.0000327	.39	.0002535	.64	.0006827	.89	.0013202	.14	.0021660	.39	.0032202	.64	.0044827	.89	.0059536
.15	.0000375	.40	.0002667	.65	.0007042	.90	.0013500	.15	.0022042	.40	.0032667	.65	.0545375	.90	.0060167
.16	.0000427	.41	.0002802	.66	.0007260	.91	.0013802	.16	.0022427	.41	.0033135	.66	.0045927	.91	.0060802
.17	.0000482	.42	.0002940	.67	.0007482	.92	.0014107	.17	.0022815	.42	.0033607	.67	.0046482	.92	.0061441
.18	.0000540	.43	.0003082	.68	.0007707	.93	.0014415	.18	.0023207	.43	.0034082	.68	.0047040	.93	.0062082
.19	.0000602	.44	.0003227	.69	.0007935	.94	.0014727	.19	.0023607	.44	.0034560	.69	.0047602	.94	.0062727
.20	.0000667	.45	.0003375	.70	.0008167	.95	.0015042	.20	.0024000	.45	.0035042	.70	.0048167	.95	.0063376
.21	.0000735	.46	.0003527	.71	.0008402	.96	.0015360	.21	.0024402	.46	.0035527	.71	.0048735	.96	.0064027
.22	.0000807	.47	.0003682	.72	.0008640	.97	.0015682	.22	.0024807	.47	.0036015	.72	.0049307	.97	.0064682
.23	.0000882	.48	.0003840	.73	.0008882	.98	.0016007	.23	.0025215	.48	.0036507	.73	.0049882	.98	.0065341
.24	.0000960	.49	.0004002	.74	.0009127	.99	.0016335	.24	.0025627	.49	.0037002	.74	.0050460	.99	.0066002
														2.00	.0066667

TABLE 3.—*Corrections to normal tape length for temperature differing from the normal (62°) by the amounts shown in the following columns.*

Tape No. II Missouri River Commission. K = difference between observed and normal temperatures. Normal length of tape at 62° F. = 300.03851 feet. Coefficient of expansion for 1° = 0.00000687. Extension for 1° = 0.00206126 foot. See Report of Chief of Engineers, 1889, p. 2759.]

° K	Correction.	° K	Correction.	° K	Correction.	° K	Correction.	° K	Correction.	° K	Correction.	° K	Correction.
	Feet.		*Feet.*		*Feet.*		*Feet.*		*Feet.*		*Feet.*		*Feet.*
0.0	0.000000	2.5	0.005153	5.0	0.010306	7.5	0.015459	10.0	0.020613	12.5	0.025766	15.0	0.030919
.1	.000206	.6	.005359	.1	.010512	.6	.015666	.1	.020819	.6	.025972	.1	.031125
.2	.000412	.7	.005565	.2	.010719	.7	.015872	.2	.021025	.7	.026178	.2	.031331
.3	.000618	.8	.005772	.3	.010925	.8	.016078	.3	.021231	.8	.026384	.3	.031537
.4	.000825	.9	.005978	.4	.011131	.9	.016284	.4	.021437	.9	.026590	.4	.031743
.5	.001031	3.0	.006184	.5	.011337	8.0	.016490	.5	.021643	13.0	.026796	.5	.031950
.6	.001237	.1	.006390	.6	.011543	.1	.016696	.6	.021849	.1	.027003	.6	.032156
.7	.001443	.2	.006596	.7	.011749	.2	.016902	.7	.022055	.2	.027209	.7	.032362
.8	.001649	.3	.006802	.8	.011955	.3	.017108	.8	.022262	.3	.027415	.8	.032568
.9	.001855	.4	.007008	.9	.012161	.4	.017315	.9	.022468	.4	.027621	.9	.032774
1.0	.002061	.5	.007214	6.0	.012368	.5	.017521	11.0	.022684	.5	.027827	16.0	.032980
.1	.002267	.6	.007421	.1	.012574	.6	.017727	.1	.022880	.6	.028033	.1	.033186
.2	.002474	.7	.007627	.2	.012780	.7	.017933	.2	.023086	.7	.028239	.2	.033392
.3	.002680	.8	.007833	.3	.012986	.8	.018139	.3	.023292	.8	.028445	.3	.033590
.4	.002886	.9	.008039	.4	.013192	.9	.018345	.4	.023498	.9	.028652	.4	.033805
.5	.003092	4.0	.008245	.5	.013398	9.0	.018551	.5	.023704	14.0	.028858	.5	.034011
.6	.003298	.1	.008451	.6	.013604	.1	.018757	.6	.023911	.1	.029064	.6	.034217
.7	.003504	.2	.008657	.7	.013810	.2	.018964	.7	.024117	.2	.029270	.7	.034423
.8	.003710	.3	.008863	.8	.014017	.3	.019170	.8	.024323	.3	.029476	.8	.034629
.9	.003916	.4	.009070	.9	.014223	.4	.019376	.9	.024529	.4	.029692	.9	.034835
2.0	.004123	.5	.009276	7.0	.014429	.5	.019582	12.0	.024735	.5	.029888	17.0	.035041
.1	.004329	.6	.009482	.1	.014635	.6	.019788	.1	.024941	.6	.030094	.1	.035247
.2	.004535	.7	.009688	.2	.014841	.7	.019994	.2	.025147	.7	.030301	.2	.035454
.3	.004741	.8	.009894	.3	.015047	.8	.020200	.3	.025353	.8	.030507	.3	.035660
.4	.004947	.9	.010100	.4	.015253	.9	.020406	.4	.025560	.9	.030713	.4	.035866
.5	.005153	5.0	.010306	.5	.015459	10.0	.020613	.5	.025766	15.0	.030919	.5	.036072
17.5	0.036072	20.0	0.041225	22.5	0.046378	25.0	0.051532	27.5	0.056685	30.0	0.061838	32.5	0.066992
.6	.036278	.1	.041431	.6	.046584	.1	.051738	.6	.056891	.1	.062044	.6	.067197
.7	.036484	.2	.041637	.7	.046791	.2	.051944	.7	.057097	.2	.062250	.7	.067403
.8	.036690	.3	.041844	.8	.046997	.3	.052150	.8	.057303	.3	.062456	.8	.067609
.9	.036897	.4	.042050	.9	.047203	.4	.052356	.9	.057509	.4	.062662	.9	.067815
18.0	.037103	.5	.042256	23.0	.047409	.5	.052562	28.0	.057715	.5	.062868	33.0	.068022
.1	.037309	.6	.042462	.1	.047615	.6	.052768	.1	.057921	.6	.063075	.1	.068228
.2	.037515	.7	.042668	.2	.047821	.7	.052974	.2	.058128	.7	.063281	.2	.068434
.3	.037721	.8	.042874	.3	.048027	.8	.053181	.3	.058334	.8	.063487	.3	.068640
.4	.037927	.9	.043080	.4	.048233	.9	.053387	.4	.058540	.9	.063693	.4	.068846
.5	.038133	21.0	.043286	.5	.048440	26.0	.053593	.5	.058746	31.0	.063899	.5	.069052
.6	.038339	.1	.043493	.6	.048646	.1	.053799	.6	.058952	.1	.064105	.6	.069258

.7	.038546	.2	.043099	.7	.048852	.2	.054005	.7	.059158	.2	.064311	.7	.069464
.8	.038753	.3	.043905	.8	.049058	.3	.054211	.8	.059364	.3	.064517	.8	.069671
.9	.038958	.4	.044111	.9	.049264	.4	.054417	.9	.059570	.4	.064724	.9	.069877
19.0	.039164	.5	.044317	24.0	.049470	.5	.054623	29.0	.059777	.5	.064930	34.0	.070083
.1	.039370	.6	.044523	.1	.049676	.6	.054829	.1	.059983	.6	.065136		
.2	.039576	.7	.044729	.2	.049882	.7	.055036	.2	.060189	.7	.065342		
.3	.039782	.8	.044935	.3	.050089	.8	.055242	.3	.060395	.8	.065548		
.4	.039988	.9	.045142	.4	.050295	.9	.055448	.4	.060601	.9	.065754		
.5	.040195	22.0	.045348	.5	.050501	27.0	.055654	.5	.060807	32.0	.065960		
.6	.040401	.1	.045554	.6	.050707	.1	.055860	.6	.061013	.1	.066166		
.7	.040607	.2	.045760	.7	.050913	.2	.056066	.7	.061219	.2	.066373		
.8	.040813	.3	.045966	.8	.051119	.3	.056272	.8	.061426	.3	.066579		
.9	.041019	.4	.046172	.9	.051325	.4	.056479	.9	.061632	.4	.066785		
20.0	.041225	.5	.046378	25.0	.051532	.5	.056685	30.0	.061838	.5	.066991		

TABLE 4.—*Geographical positions north of Keokuk, Iowa.*

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
○ Lower Base	41	34	31.67	977.0	90	21	57.73	1,337.3	249	03	09.2	69	03	52.2	○ Upper Base	1,604.8
○ Upper Base	41	34	50.26	1,550.6	90	20	53.04	1,228.6	140	04	57.7	320	04	32.5	○ Le Claire	1,373.2
									240	23	50.1	60	24	19.2	○ Rapids City	1,169.5
△ Le Claire	41	35	24.40	752.8	90	21	31.08	729.9	20	47	02.0	200	46	45.0	○ Lower Base	
									56	21	21.3	236	20	51.4	○ Sycamore	1,255.1
									284	03	32.6	104	04	27.0	○ Rapids City	1,956.7
									199	58	40.3	19	58	58.4	○ Le Boone	1,841.9
									318	12	56.0				△ Rapids City Spire	1,538.0
									233	04	46.0	53	05	14.0	△ Le Claire Belfry	1,231.0
△ Rapids City Spire	41	34	47.22	1,456.8	90	20	46.84	1,085.0	102	18	44.0	282	17	44.0	○ Sycamore	2,118.3
△ Rapids City	41	35	08.98	277.0	90	20	09.14	211.7	150	06	52.1	330	06	15.7	○ Le Boone	2,545.2
									185	34	57.5	5	35	04.4	○ Port Byron	2,455.5
									85	25	13.5	245	24	01.5	○ Lower Base	
									65	01	08.6				○ Crab Island	
									80	29	04.5				○ Fulton	
									76	50	09.4				○ Valley City	
									52	27	36.0	232	27	11.0	△ Rapids City Spire	1,101.6
									143	03	39.0	323	03	12.8	△ Le Claire Belfry	1,520.2
									156	54	36.5	336	54	16.6	△ Le Claire Spire	1,767.3
									180	31	41.5	0	31	42.1	△ Port Byron Spire No. 1	2,300.2
									181	24	35.1	1	24	36.6	△ Port Byron Spire No. 2	2,180.5
△ Le Claire Belfry	41	35	48.37	1,492.2	90	20	48.59	1,125.2								
△ Le Claire Spire	41	36	01.68	51.8	90	20	39.07	904.8								
△ Port Byron Spire No. 1	41	36	23.54	726.2	90	20	08.23	190.6								
△ Port Byron Spire No. 2	41	36	19.64	605.9	90	20	06.83	158.2								
○ Le Boone	41	36	20.51	632.7	90	21	03.91	90.5	261	02	54.6	81	03	37.8	○ Port Byron	1,525.6
									180	49	40.6	0	49	41.9	○ Hopson	3,139.9
									271	09	21.6				△ Port Byron Spire No. 2	1,322.1
△ Port Byron	41	36	28.20	870.0	90	19	58.82	1,362.2	153	16	49.8	333	16	07.8	○ Hopson	3,249.5
									186	34	35.8	6	34	50.1	○ Woodward	4,330.4
									48	43	20.4	228	42	53.7	△ Le Claire Spire	1,240.1
									56	34	18.4	236	34	12.2	△ Port Byron Spire No. 1	260.8
									35	03	29.8	215	03	24.5	△ Port Byron Spire No. 2	322.5
△ Hopson	41	38	02.27	70.0	90	21	01.95	45.1	234	25	14.5	54	26	10.6	○ Woodward	2,405.9
									182	49	41.3	2	49	46.5	○ Princeton	3,733.3
△ Woodward	41	38	47.04	1,409.7	90	19	37.39	805.2	142	44	28.5	322	43	37.6	○ Princeton	2,926.7
									202	18	03.9	22	18	34.5	○ Cordova	2,808.4
△ Princeton	41	40	03.14	96.9	90	20	53.98	1,248.8	264	34	19.9	84	35	41.5	○ Cordova	2,850.3
									172	51	20.2	352	51	03.6	○ Wapsie	4,659.1
									239	54	52.2	59	55	51.6	△ Cordova Spire	2,388.1

Cordova	41	40	11.86	365.9	90	18	51.32	1,187.2	141	53	37.1	321	51	58.9	Wapsie	5,534.2
									193	59	50.0	14	00	45.9	Evergreen	6,747.7
									270	37	33.7	90	41	10.9	Rocks	7,555.1
Wapsie	41	42	32.98	1,017.5	90	21	19.05	440.4	246	29	35.8	06	32	01.1	Evergreen	5,563.3
									322	18	55.6	142	20	11.6	Cordova Spire	4,328.5
Cordova Spire	41	40	41.93	1,293.6	90	19	24.65	570.1								
Evergreen	41	43	44.07	1,359.6	90	17	40.70	940.6	318	14	23.1	138	17	13.3	Rocks	8,889.8
									240	37	41.5	60	40	08.6	Marais D'Osier	5,858.7
									189	14	40.6	9	15	20.1	Camanche	8,521.5
Rocks	41	40	09.05	279.2	90	13	24.76	572.8	175	08	32.5	355	08	09.2	Marais D'Osier	9,539.4
Marais D'Osier	41	45	17.14	528.8	90	13	53.72	1,379.8	146	02	02.9	326	00	15.2	Camanche	6,680.1
									195	04	44.2	15	05	10.5	Albany	3,507.2
									63	31	44.2				Wapsie	
Camanche	41	48	16.69	514.9	90	16	41.39	955.6	294	50	55.0	114	53	09.1	Albany	5,119.6
									242	03	00.2	62	06	01.4	Clinton	7,099.2
Albany	41	47	06.90	212.9	90	13	20.21	466.8	196	33	43.0	16	34	30.0	Clinton	5,714.8
									231	51	02.6	51	54	40.0	Ferris	9,569.8
									187	45	14.0				Albany Spire	
Clinton	41	50	04.45	137.3	90	12	09.61	221.7	265	48	26.4	85	51	16.9	Ferris	5,912.6
									202	35	00.8	22	36	12.7	Lyons	6,472.0
									203	24	53.4	23	25	54.0	Lyons Spire	5,267.6
Ferris	41	50	18.38	567.0	90	07	54.04	1,246.9	148	26	24.6	328	24	46.0	Lyons	6,509.0
									210	23	50.3	30	26	24.9	Jack Green	10,545.6
									139	13	01.9	319	11	11.9	Lyons Spire	5,817.1
Lyons Spire	41	52	41.11	1,268.3	90	10	38.84	895.5								
Lyons	41	53	18.12	559.0	90	10	21.81	502.8	247	52	28.8	67	56	42.2	Jack Green	9,435.9
									181	47	14.0	1	47	24.4	Elk River	11,510.4
Jack Green	41	55	13.13	405.1	90	04	02.48	57.2	133	33	30.0	313	29	26.8	Elk River	11,553.2
									179	19	35.6	359	19	33.1	Dyson	7,297.5
Elk River	41	59	31.01	956.7	90	10	06.21	142.9	274	30	56.7	94	34	57.5	Dyson	8,313.1
									175	06	19.3	355	06	04.0	Sabula	6,159.0
Dyson	41	59	09.64	297.4	90	04	06.20	142.7	127	41	03.7	307	36	47.4	Sabula	11,125.9
									169	34	23.7	349	33	42.1	Bristol	7,897.4
									155	34	09.3				Savanna	
Sabula	42	02	49.91	1,540.0	90	10	29.06	668.2	262	28	11.7	82	31	46.6	Bristol	7,438.6
									197	43	07.4	17	44	16.1	Savanna	7,742.2
									154	20	22.1	334	17	55.7	Lainsville	11,584.1
Bristol	42	03	21.38	659.7	90	05	08.36	192.2	141	57	37.4	321	55	11.2	Savanna	8,132.8
Savanna	42	06	48.92	1,509.5	90	08	46.50	1,068.2	112	36	15.5	292	32	40.2	Lainsville	7,085.0
									149	24	39.3	329	23	30.1	Miller	4,660.2
Lainsville	42	06	28.27	872.3	90	14	07.51	172.5	259	15	55.2	79	18	21.3	Miller	5,088.2
									156	20	30.5	336	19	33.8	Apple River	4,834.4
									111	59	47.6	291	55	28.1	Green Island	9,571.4
Miller	42	08	58.93	1,818.4	90	10	29.78	683.7	116	40	36.7	296	37	13.8	Apple River	7,763.0
									359	54	57.2				Sabula	
Apple River	42	10	51.78	1,597.7	90	15	32.04	735.3	83	03	08.7	262	59	45.9	Green Island	6,985.8
									139	36	55.2	319	34	51.9	Hanover	6,495.2
Green Island	42	10	24.28	749.2	90	20	34.17	784.3	205	08	48.2	25	10	07.9	Hanover	6,402.0
									144	06	05.2	324	04	16.1	Harrington	6,351.7
Hanover	42	13	32.09	990.2	90	18	35.54	814.9	84	15	48.7	264	12	39.9	Harrington	6,477.5
									131	49	26.0	311	46	41.3	Blanding	7,533.7

TABLE 4.—*Geographical positions north of Keokuk, Iowa*—Continued.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
Harrington	42 13 11.01	339.7	90 23 16.55	379.6	188 16 58.5	8 17 22.7	Blanding	5,731.8
					148 03 27.5	328 01 32.5	Rogers	7,410.1
Blanding	42 16 14.84	457.9	90 22 40.52	228.6	97 24 07.7	277 21 48.4	Rogers	4,786.0
					163 30 55.3	343 30 11.1	Wise	5,299.0
					67 44 38.0		Bellevue Catholic Church	
					69 24 26.0		Bellevue E. M. Church	
Rogers	42 16 34.77	1,072.9	90 26 07.64	175.1	215 57 01.6	35 58 36.8	Wise	5,517.8
					171 28 48.8	351 28 17.7	Smith	7,143.7
Wise	42 18 59.51	1,836.2	90 23 46.18	1,057.5	121 10 48.4	301 08 42.0	Smith	5,022.0
					177 32 06.5	357 31 53.6	Horseshoe	10,180.7
Smith	42 20 23.74	732.5	90 26 53.87	1,233.3	206 58 15.8	27 00 09.4	Horseshoe	8,497.8
					136 53 59.1	316 51 09.1	Gordons Ferry	8,443.0
					188 55 31.8	8 56 11.0	Galena Spire	8,710.7
					121 46 54.8	301 41 05.7	Iowa Spire	13,938.9
Galena Spire	42 25 02.64	81.5	90 25 54.76	1,252.0				
Horseshoe	42 24 29.16	899.8	90 24 05.33	121.0	81 42 08.5	261 37 24.8	Gordons Ferry	9,725.6
					117 58 34.3	297 53 55.6	Heffernan	10,688.1
					137 59 40.6	317 53 54.7	Sinsinawa	17,472.7
					223 35 32.7	43 42 32.9	Gratiots Grove	20,595.4
					112 26 40.4	292 25 26.6	Galena Spire	2,707.1
					89 11 19.1	269 03 36.0	Iowa Spire	15,705.6
					116 15 09.4	296 13 55.1	Astronomical Post	2,810.1
Gordons Ferry	42 23 45.46	1,341.0	90 31 06.10	139.5	181 34 09.2	1 34 14.4	Heffernan	6,420.1
					108 47 40.5	288 45 50.4	Hubbard	3,943.3
					171 44 15.7	351 43 13.9	Sinsinawa	14,535.2
Sinsinawa C. S	42 31 29.63	914.3	90 32 37.61	858.5	265 38 05.4	85 50 52.5	Gratiots Grove	25,965.8
					347 56 16.8		Menominee Spire	
Gratiots Grove C. S	42 32 32.12	991.1	90 13 42.98	980.6				
Iowa Spire	42 24 21.37	659.4	90 35 32.07	733.4				
Galena Astronomical Post	42 25 09.43	291.0	90 25 55.56	1,270.3				
Heffernan	42 27 11.45	353.3	90 30 58.40	1,334.6	37 12 53.8	217 10 58.5	Hubbard	6,463.2
					102 32 00.3	282 30 00.8	Rickey	4,143.3
					50 02 00.0	229 58 55.4	Iowa Spire	8,165.0
Hubbard	42 24 24.60	759.1	90 33 49.34	1,128.4	178 40 59.2	358 40 55.1	Rickey	6,047.8
					121 55 44.4	301 53 41.1	Gassman	4,922.3
					87 34 55.7	267 33 46.4	Iowa Spire	2,351.5
					263 46 51.2		Galena Spire	10,915.1
Rickey	42 27 40.55	1,251.2	90 33 55.43	1,266.4	49 33 03.2	229 31 04.0	Gassman	5,307.0
					91 47 23.1	271 44 32.7	Catfish	5,770.7
					132 51 46.7	312 49 28.5	Cutler	6,373.7
					19 46 54.3	199 45 49.1	Iowa Spire	6,530.8

Gassman	42	25	48.92	1,509.5	90	36	52.10	1,190.0	101	44	49.5	281	41	08.4	Mothers Convent	7,639.7
									118	25	15.1	298	21	13.6	Court House	9,284.7
									154	27	07.3	334	26	16.1	Catfish	4,014.8
									152	16	12.0	332	14	09.8	Court House	8,879.4
									157	09	28.5				Shot Tower	
Catfish	42	27	46.31	1,428.9	90	38	07.88	180.0	194	43	43.7	14	44	16.0	Cutler	4,297.6
									132	25	23.1	312	24	30.7	Convent	2,402.2
									234	40	03.0	54	40	47.2	Lower Base	1,832.9
									179	47	04.6	359	47	04.5	Upper Base	
Cutler	42	30	01.01	31.2	90	37	20.03	457.4	99	00	01.5	278	57	56.3	Dubuque	4,283.6
									180	48	13.0	0	48	14.6	Freese	3,783.3
									45	14	39.2	225	13	16.2	Mothers Convent	3,951.5
									346	44	42.3				Iowa Spire	
Convent	42	28	38.82	1,197.8	90	39	25.52	582.9	228	28	53.7	48	30	18.4	Cutler	3,826.8
									279	42	57.4	99	44	34.0	Lower Base	3,316.3
									240	30	59.7	60	31	51.8	Upper Base	2,025.5
									156	55	02.7	336	54	22.3	Dubuque	3,483.9
									185	16	58.8	5	17	05.7	Shot Tower	2,530.9
									166	29	07.7	346	28	49.1	Court-house	2,690.9
									166	00	31.3	346	00	06.5	St. Marys Church	3,462.5
									166	34	47.8	346	34	35.6	Illinois Central Depot	1,774.5
Upper Base	42	29	11.12	343.1	90	38	08.31	189.8	315	58	05.6	135	58	50.1	Lower Base	2,165.5
									125	13	32.1	305	11	55.3	Dubuque	3,829.7
									53	52	25.2	233	51	34.8	Mothers Convent	2,108.7
									124	06	51.6	304	05	40.9	Court-house	2,888.7
Lower Base	42	28	20.66	637.5	90	37	02.42	55.3	95	35	46.1	275	34	11.3	Mothers Convent	3,223.7
									129	12	01.1				Court-house	
Mothers Convent	42	28	30.83	951.3	90	39	22.87	522.5								
Dubuque	42	30	22.69	700.1	90	40	25.34	578.6	233	57	43.6	53	50	50.4	Freese	5,295.5
									190	28	34.6	10	28	59.4	Schubert	4,614.7
									293	10	31.7	113	11	19.0	Shot Tower	1,739.4
									265	51	06.3	85	52	29.4	Boundary Stone	2,815.4
									308	36	07.5				Court-house	943.3
									253	40	34.5				St. Marys Church	550.9
									337	32	17.3				Mothers Convent	
Shot Tower	42	30	00.50	15.4	90	39	15.31	349.6								
Court-house	42	30	03.61	111.4	90	39	53.05	1,211.3								
St. Marys Spire	42	30	27.71	855.0	90	40	02.18	49.8								
Illinois Central Depot	42	29	34.76	1,072.6	90	39	43.55	994.4								
Boundary Stone	42	30	29.27	903.1	90	38	22.35	510.4								
Freese	42	32	03.61	111.4	90	37	17.71	404.1	112	28	52.1	292	27	10.1	Schubert	3,725.2
									148	06	03.8	328	04	27.2	Fenley	6,165.9
									51	46	11.2	231	44	20.0	St. Marys Church	4,780.4
									35	57	08.4	215	55	29.8	Illinois Central Depot	5,672.8
									26	53	04.7	206	52	21.0	Boundary Stone	3,263.6
									35	15	34.2				Shot Tower	4,651.7
									43	46	44.0				Court-house	
Schubert	42	32	49.75	1,535.1	90	39	48.57	1,108.1	182	44	06.0	2	44	11.3	Fenley	3,814.7
									4	03	31.5				St. Marys Church	4,394.0
Fenley	42	34	51.24	1,642.8	90	39	40.58	925.3	108	46	59.4	288	44	58.1	Maquoketa	4,316.2
									165	09	29.0	345	08	39.2	Platte River	6,663.3

TABLE 4.—*Geographical positions north of Keokuk, Iowa*—Continued.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊙ Maquoketa	42	35	38.26	1,180.6	90	42	39.90	909.6	323	03	27.3	143	05	23.2	⊙ Schubert	6,504.3
									205	12	39.8	25	13	50.4	⊙ Platte River	5,583.8
									146	59	29.8	326	58	03.9	⊙ Specht's Ferry	5,305.1
									99	25	09.8	279	21	47.5	⊙ Sherrils Mound	6,907.2
									99	18	13.8	279	15	18.9	△ S. M. Spire	5,970.2
⊙ Platte River	42	38	21.97	677.9	90	40	55.50	1,264.6	83	29	17.7	263	26	41.1	⊙ Specht's Ferry	5,302.9
									129	55	33.4	309	53	50.5	⊙ Potosi	4,509.2
									63	43	18.3	243	39	12.6	△ S. M. Spire	9,225.2
⊙ Specht's Ferry	42	38	02.42	74.7	90	44	46.73	1,064.7	207	20	28.9	27	21	22.7	⊙ Potosi	3,036.5
									122	41	07.7	302	39	51.6	⊙ Kratz	3,041.1
									49	45	26.0	229	43	29.5	⊙ Sherrils Mound	5,139.0
									40	43	34.5	220	42	05.4	△ S. M. Spire	4,598.4
⊙ Sherrils Mound C. S	42	36	14.79	456.3	90	47	38.82	885.0	280	05	39.4	.....	.....	.....	△ S. M. Spire	.....
△ Sherrills Mound Spire	42	36	09.46	291.9	90	46	58.34	1,330.0	.....	.....	.....	.....	.....	.....	.....	.....
⊙ Potosi	42	39	55.73	1,719.6	90	43	27.34	622.7	67	00	31.2	246	58	21.3	⊙ Kratz	4,744.9
									99	27	11.3	279	24	55.6	⊙ Grant River	4,623.5
									34	34	13.4	214	31	50.5	△ S. M. Spire	8,477.6
									75	15	07.9	255	09	15.2	△ Holy Cross Spire	12,265.0
⊙ Kratz	42	38	55.63	1,716.5	90	46	39.10	890.7	175	44	44.6	355	44	38.8	⊙ Grant River	2,019.8
									105	44	52.8	285	43	04.9	⊙ Rumpel	3,768.5
⊙ Grant River	42	40	20.30	626.4	90	46	47.63	1,084.7	65	08	51.8	245	07	09.6	⊙ Rumpel	3,782.9
									100	52	03.8	280	49	39.7	⊙ McCartney	4,926.6
⊙ Rumpel	42	39	28.74	886.8	90	49	18.34	417.8	150	48	26.3	330	47	44.5	⊙ McCartney	2,884.4
									104	44	10.1	284	42	07.5	⊙ Waupeton	4,260.6
⊙ McCartney	42	40	50.34	1,553.3	90	50	20.13	458.3	62	07	42.0	242	06	21.2	⊙ Waupeton	3,009.3
									103	26	34.5	283	24	07.4	⊙ Sparks	5,080.4
									342	02	14.7	.....	.....	.....	△ S. M. Spire	.....
⊙ Waupeton	42	40	03.83	118.2	90	52	19.28	439.0	139	33	24.3	319	32	17.9	⊙ Sparks	3,436.2
									105	10	00.0	285	07	11.9	⊙ Buena Vista	5,834.8
									285	09	43.0	.....	.....	.....	⊙ Kratz	.....
⊙ Sparks	42	41	28.57	881.6	90	53	57.20	1,302.3	72	14	27.7	252	12	46.4	⊙ Buena Vista	3,572.4
									109	22	00.9	289	19	43.6	⊙ Jaco	4,883.3
									337	27	10.8	157	28	24.9	△ Holy Cross Spire	6,492.8
⊙ Buena Vista	42	40	53.23	1,642.5	90	56	26.63	606.2	155	59	44.9	335	59	09.0	⊙ Jaco	2,964.8
									107	58	54.0	287	56	12.7	⊙ Spring Lake	5,092.8
									133	47	16.0	.....	.....	.....	△ Cassville Spire	4,927.2
									284	55	24.4	.....	.....	.....	⊙ Rumple	.....
									274	21	09.9	.....	.....	.....	⊙ Grant River	.....
⊙ Jaco	42	42	21.00	648.0	90	57	19.63	446.8	77	15	26.3	257	13	20.9	⊙ Spring Lake	4,314.8
									37	52	16.1	217	51	27.5	⊙ Brown House	2,657.6
									140	06	32.9	320	04	83.5	⊙ Kerschbaum	5,980.4
									316	59	18.4	.....	.....	.....	△ Holy Cross Spire	10,412.6

Spring Lake	42	41	50.12	1,546.5	91	00	24.52	558.1	293	56	31.4	113	57	48.2	Brown House	2,820.5
									234	58	56.0	54	59	53.3	West Base	2,348.6
									260	01	12.1	80	03	10.0	East Base	
									183	49	05.8	3	49	16.8	Kirschbaum	5,552.8
									131	07	39.6	311	04	08.7	Klinehunt	9,382.1
									286	29	09.9				Waupeton	
									228	18	40.5	48	19	35.8	Cassville Spire	2,486.1
									141	26	02.4				Guttenburg Spire	11,934.2
Brown House	42	41	13.01	401.4	90	58	31.20	712.4	165	18	34.0	345	18	14.5	West Base	2,576.7
									216	50	02.7	36	50	43.8	East Base	2,299.0
									165	33	59.0	345	33	37.5	Cassville Spire	2,889.5
									136	18	10.0				Guttenburg Spire	
West Base	42	42	33.78	1,042.3	90	59	00.00	0.0	287	47	47.6	107	48	48.2	East Base	2,133.9
East Base	42	42	12.63	389.7	90	57	30.73	609.4								
Cassville Spire	42	42	43.60	1,348.1	90	59	02.94	66.9								
Holy Cross Spire	42	38	14.22	438.8	90	52	07.93	180.7								
Kirschbaum	42	44	49.67	1,532.6	91	00	08.26	187.9	94	50	55.5	274	47	13.5	Klinehunt	7,463.5
									150	51	14.6	330	49	34.4	Spoden	6,882.1
									341	43	33.5				Brown House	
									318	05	22.5				Holy Cross Spire	
Klinehunt	42	45	09.99	308.2	91	05	35.28	802.4	217	08	51.6	37	10	53.5	Spoden	6,755.0
									168	19	25.3	348	18	39.3	Esmer	7,606.3
									296	47	36.0				Cassville Spire	
									175	26	32.1				School House	
Spoden	42	48	04.44	137.0	91	02	35.77	812.8	110	12	37.4	290	09	49.3	Esmer	5,985.8
									142	08	32.3	322	07	16.4	Glen Haven	4,133.3
Esmer	42	49	11.38	351.1	91	06	43.04	977.8	248	44	37.6	68	46	09.8	Glen Haven	3,304.5
									176	01	57.7	356	01	50.5	Jung	3,496.4
									344	48	41.6	164	49	16.4	Guttenburg Spire	4,444.0
Glen Haven	42	49	50.18	1,548.4	91	04	27.45	623.4	124	36	32.9	304	34	53.5	Jung	4,034.5
									178	44	32.1	358	44	27.9	Sandy Creek	6,390.2
									21	51	06.3				Guttenburg Spire, No. 2	
									21	27	01.9				School House	
Guttenburg Spire	42	46	52.39	1,616.5	91	05	51.82	1,177.9								
Jung	42	51	04.41	136.1	91	06	53.70	1,219.3	217	47	28.3	37	49	03.6	Sandy Creek	5,186.7
									171	56	47.5	351	56	30.7	Langworthy	4,010.3
									306	49	37.5	126	51	13.0	G. H. Water Tank	3,986.8
									307	12	57.0				G. H. Spire	
									319	37	38.5				Holy Cross Spire	
Sandy Creek	42	53	17.22	531.3	91	04	33.63	763.2	88	04	01.4	268	02	09.2	Langworthy	3,742.3
									134	30	06.6	314	28	15.1	Bagley	5,206.3
									21	11	02.9				Esmer	
									5	19	38.4				Klinehunt	
									359	54	47.1	179	54	47.4	G. H. Water Tank	6,488.5
									105	45	32.6	285	42	40.5	Clayton Spire	5,958.7
									8	20	47.9				School House	
Langworthy	42	53	13.09	403.9	91	07	18.46	418.9	180	22	41.3	0	22	42.0	Bagley	3,775.6
									135	04	59.9	315	03	23.6	Clayton	4,543.5
									131	08	42.7				Clayton Church	2,649.8
									235	54	28.0				Bagley Spire	
G. H. Water Tank	42	49	46.95	1,448.7	91	04	33.20	734.1								
Clayton Spire	42	54	09.59	295.9	91	08	46.42	1,053.2								

TABLE 4.—*Geographical positions north of Keokuk, Iowa*—Continued.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
◬ Bagley	42 55 15.44	476.4	91 07 17.36	393.7	89 12 22.7	269 10 45.7	◬ Clayton	3,280.8
					185 27 59.7	5 28 13.2	◬ Clark	4,712.0
◬ Clayton	42 54 57.33	1,769.0	91 09 39.90	905.0	215 01 20.4	35 03 11.0	◬ Clark	6,411.3
					170 32 24.1	350 31 57.8	◬ Peterson	5,311.4
◬ Clark	42 57 47.45	1,464.1	91 06 57.55	1,304.2	89 53 23.4	269 51 06.5	◬ Peterson	4,552.4
					158 00 03.6	337 59 30.1	◬ Wisconsin Point	2,978.7
					100 57 28.9		Church Spire	
◬ Peterson	42 57 47.12	1,453.9	91 10 18.42	417.4	231 05 09.6	51 06 53.0	◬ Wisconsin Point	4,414.3
					187 23 16.4	7 23 30.1	◬ Drake	3,524.4
					342 43 40.3	162 44 43.0	◬ Clayton Spire	7,029.3
					157 49 20.6		◬ Church Spire	1,043.2
◬ Church Spire	42 58 18.42	568.4	91 10 35.79	311.1				
◬ Wisconsin Point	42 59 16.95	523.0	91 07 46.80	1,060.4	103 38 46.4	283 37 16.6	◬ Drake	3,067.8
					175 02 18.8	355 02 05.8	◬ Prairie du Chien	4,983.3
					64 45 54.5	244 43 59.3	◬ Church Spire	4,238.5
					173 20 45.6	353 20 27.3	◬ School House	5,246.7
◬ Drake	42 59 40.38	1,246.0	91 09 58.41	1,323.0	210 59 41.9	31 00 58.7	◬ Prairie du Chien	4,948.6
					170 50 01.8	350 49 27.0	◬ North McGregor	7,237.6
					184 53 24.9		◬ Dousman House	6,546.0
◬ Prairie du Chien	43 01 57.83	1,784.7	91 08 05.84	132.2	18 31 07.6	198 30 42.1	◬ Church Spire	2,667.1
					128 07 52.5	308 06 00.8	◬ North McGregor	4,704.1
					179 18 53.1	359 18 51.2	◬ Dousman	5,065.8
					144 19 33.6	324 19 28.3	◬ School House	303.5
◬ North McGregor	43 03 31.93	985.4	91 10 49.36	1,116.8	239 16 19.7	59 18 09.5	◬ Dousman	4,232.7
					278 43 52.5	98 44 59.9	◬ South Base	2,259.1
					238 21 23.6	58 22 25.6	◬ North Base	2,413.6
					290 00 19.4	110 01 11.0	◬ Dousman House	1,821.0
					271 04 50.7		◬ Church Spire No. 1	2,758.4
					289 06 02.9	109 07 33.0	◬ Church Spire No. 2	3,150.7
					307 00 00.0	127 01 47.2	◬ School House	4,413.6
					312 10 28.4	132 12 01.8	◬ Catholic School No. 1	4,181.7
					300 38 24.4	120 39 44.7	◬ Catholic School No. 2	3,095.6
◬ Dousman	43 04 41.98	1,295.6	91 08 08.52	192.7	29 19 14.9	209 18 32.5	◬ South Base	2,873.0
					60 30 57.0	240 30 09.1	◬ North Base	1,819.9
					34 42 30.6	214 41 31.7	◬ Dousman House	3,387.6
					21 42 47.3	201 42 20.7	◬ Church Spire No. 1	2,383.5
					11 34 20.8	191 34 01.1	◬ Church Spire No. 2	3,202.7
					1 22 55.0	181 22 51.5	◬ School House	4,820.4
					6 13 31.3	186 13 14.9	◬ Catholic School No. 1	4,999.6
					14 38 32.8	194 38 03.3	◬ Catholic School No. 2	3,865.5

| | | |

TABLE 4a.—*Geographical positions of tertiary points north of Keokuk, Iowa.*

[Referred to Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ 15^{A}_{2}	41	35	48.40	1,493.2	90	20	10.91	252.7	128	55	05	308	54	30	ⓐ Le Boone	1,577.1
									358	03	51	178	03	52	ⓒ Rapids City	1,216.6
									87	40	48	267	40	28	⊡ 18^{A}_{4}	694.6
⊡ 18^{A}_{4}	41	35	47.48	1,464.8	90	20	40.88	946.7	328	14	26	148	14	47	ⓒ Rapids City	1,396.9
⊡ 18^{A}_{5}	41	38	55.45	1,710.7	90	20	18.61	430.6	31	26	36	211	26	07	ⓐ Hopson	1,922.8
									87	28	23	267	27	59	⊡ 18^{A}_{5}	821.0
⊡ 15^{A}_{3}	41	38	54.27	1,674.3	90	20	54.06	1,250.9	344	09	22	164	09	59	ⓐ Port Byron	4,684.4
									6	29	39	186	29	34	ⓐ Hopson	1,014.6
									211	54	19				△ Cordova Spire	
⊡ 15^{B}_{6}	41	40	39.79	1,227.5	90	17	50.91	1,177.5	58	20	38	238	19	58	ⓐ Cordova	1,641.9
⊡ 18^{B}_{6}	41	40	56.80	1,752.3	90	19	00.38	8.8								
⊡ 15^{B}_{3}	41	41	12.38	331.9	90	20	38.39	887.9	159	17	34	339	17	07	ⓐ Wapsie	2,658.4
									117	38	06	297	37	42	⊡ 18^{B}_{2}	957.6
⊡ 18^{B}_{6}	41	41	26.78	826.2	90	21	15.07	348.6	177	25	26	357	25	23	ⓐ Wapsie	2,044.5
⊡ 18^{B}_{7}	41	43	49.05	1,513.2	90	18	36.38	840.7	270	48	16	96	48	53	ⓐ Evergreen	1,290.2
⊡ 15^{B}_{7}	41	44	09.98	307.9	90	19	20.75	479.5								
⊡ 18^{B}_{1}	41	45	11.41	352.0	90	16	47.13	1,088.9	24	40	47	204	40	11	ⓐ Evergreen	2,965.2
									173	35	20	353	35	17	⊡ 18^{B}_{8}	1,002.6
⊡ 15^{B}_{8}	41	45	43.70	1,348.2	90	16	51.98	1,200.6	145	25	35	325	25	22	⊡ 18^{B}_{8}	801.5
⊡ 15^{B}_{9}	41	46	03.80	117.2	90	17	11.67	269.6								
⊡ 15^{B}_{10}	41	47	12.29	379.1	90	13	39.66	915.9	117	43	03	297	42	32	⊡ 18^{B}_{9}	1,213.3
⊡ 15^{B}_{11}	41	47	30.57	943.1	90	14	26.18	604.4	295	36	36	115	37	20	ⓐ Albany	1,689.1
									351	33	23	171	33	40	ⓐ Marais d'Osier	4,161.7
									109	08	30	289	08	08	⊡ 15^{B}_{11}	828.3
⊡ 15^{B}_{1}	41	47	39.38	1,214.9	90	15	00.07	1.6	293	28	42	113	29	48	ⓐ Albany	2,514.1
									342	22	26	162	23	06	ⓐ Marais d'Osier	4,604.3
									116	12	19				△ Camanche	
⊡ 15^{B}_{12}	41	48	19.25	593.9	90	10	33.14	765.1	114	08	13	294	07	52	⊡ 18^{B}_{12}	815.9
⊡ 18^{B}_{12}	41	48	30.66	927.4	90	11	05.40	124.6								
⊡ 15^{B}_{4}	41	49	08.81	271.8	90	13	08.46	195.3	4	07	35	184	07	28	ⓐ Albany	3,770.7
									253	29	31	73	33	01	ⓐ Ferris	7,566.3
⊡ 18^{A}_{1}	41	50	56.12	1,731.3	90	09	57.06	1,316.3	126	03	33	306	03	18	⊡ 18^{A}_{1}	648.5
⊡ 18^{A}_{2}	41	51	08.50	262.2	90	10	19.79	456.5	52	03	35	232	02	22	ⓐ Clinton	3,213.1
									170	20	01	350	20	00	ⓐ Lyons	3,999.4
									116	46	40	296	46	10	⊡ 15^{A}_{1}	1,154.2
									171	17	01				△ Lyons Spire	
⊡ 18^{A}_{3}	41	51	25.35	782.1	90	11	04.46	102.9								
⊡ 15^{A}_{2}	41	51	10.52	324.6	90	08	44.88	1,094.8	95	53	57	275	58	53	ⓐ Lyons	2,247.1
⊡ 18^{A}_{8}	41	53	17.91	552.5	90	09	31.47	725.6	101	36	51	281	36	19	⊡ 18^{A}_{8}	1,139.0
⊡ 15^{A}_{3}	41	53	25.34	781.7	90	10	19.86	457.9								
⊡ 18^{A}_{9}	41	56	00.35	10.8	90	08	55.45	1,277.5	97	25	21	277	25	46	⊡ 18^{A}_{9}	860.9
⊡ 15^{A}_{4}	41	56	03.96	122.2	90	09	32.50	748.8								

	41	58	23.28	718.2	90	08	47.41	1,091.7	88	18	39	268	17	53	1,591.5
	41	58	21.76	671.3	90	09	56.51	1,301.2	136	59	23	316	59	02	1,056.1
	41	58	46.79	1,443.5	90	10	27.81	640.2							
	42	01	17.35	535.3	90	08	02.35	54.1	61	20	58	241	20	38	778.0
	42	01	05.26	162.3	90	08	32.02	736.8	61	29	27	241	20	07	765.1
	42	00	53.36	1,646.5	90	09	01.20	27.6	61	03	00	241	02	42	727.5
	42	00	41.05	1,294.4	90	09	28.86	664.1							
	42	03	22.51	694.6	90	09	20.66	475.1	78	56	57	258	56	41	541.5
	42	03	19.14	590.6	90	09	43.77	1,006.6	78	53	55	258	53	30	850.6
									49	06	26	229	05	55	Sabula
	42	03	13.83	426.7	90	10	20.07	461.5	15	38	47	195	38	41	Sabula 766.6
	42	06	09.53	294.1	90	09	31.30	719.3	89	30	21	269	30	07	467.6
									12	10	13				Sabula
	42	06	09.40	290.0	90	09	51.65	1,186.8	89	26	09	209	25	47	742.0
									321	17	47				Savanna Spire (tallest)
	42	06	09.16	282.6	90	10	23.94	550.1							
	42	08	21.30	657.2	90	11	24.07	552.8	51	23	31	231	23	12	841.0
	42	08	04.28	132.1	90	11	52.68	1,209.9	51	21	56	231	21	38	800.2
	42	07	48.09	1,483.9	90	12	19.90	457.1	290	24	25	110	26	48	Savanna 5,230.9
									229	09	22	49	10	36	Miller 3,342.4
	42	10	25.50	786.8	90	12	55.68	1,278.1	59	17	38	239	17	12	1,058.7
	42	10	07.98	246.2	90	13	35.33	810.9	50	40	10	230	39	46	1,029.5
									296	33	22	116	35	26	Miller 4,762.7
									13	30	18	103	29	56	Lainsville 3,163.0
	42	09	46.83	1,445.0	90	14	10.02	230.0	286	16	26	106	18	53	Miller 5,267.8
									43	27	38	223	27	24	670.7
	42	09	31.05	958.1	90	14	30.12	691.4							
	42	12	19.50	601.7	90	18	13.01	298.5	359	49	20	179	49	20	1,350.8
	42	11	35.53	1,096.3	90	18	12.82	294.1	25	42	37	205	42	28	739.0
									315	42	54	135	45	30	Lainsville 8,067.6
									55	53	08	235	51	33	Green Island 3,918.4
									112	56	57				Harrington 7,564.2
	42	11	13.95	430.4	90	18	26.79	614.8	25	20	57	205	29	48	716.5
	42	10	52.99	1,635.1	90	18	40.23	923.2							
	42	12	46.82	1,444.7	90	19	27.25	625.0	51	12	30	231	12	13	749.0
									19	15	17	199	14	32	Green Island 4,058.0
									98	05	57	278	03	23	Harrington 5,312.1
									220	19	09				Hanover 1,832.1
	42	12	31.60	975.1	90	19	52.70	1,208.7	45	40	26	225	39	58	1,343.5
	42	12	01.18	36.4	90	20	34.59	793.6	28	42	59	208	42	52	465.0
	42	11	47.96	1,479.9	90	20	44.32	1,016.8							
P. B. M. 317-318	42	12	15.80	487.5	90	19	33.22	762.2							
P. B. M. 319-320	42	12	13.90	428.9	90	19	31.26	717.2							
	42	14	03.92	121.0	90	22	55.64	1,275.8	53	15	52	233	15	38	595.7
	42	13	52.37	1,615.9	90	23	16.46	377.4	52	56	17	232	55	55	942.6
									0	05	53	180	05	53	Harrington 1,270.2
	42	13	33.95	1,047.6	90	23	49.26	1,120.5							
	42	16	18.71	577.3	90	24	19.25	441.2	56	39	34	236	39	11	967.7
									101	17	43	281	16	30	Rogers 2,532.7
									281	00	28				Blanding
	42	16	01.47	45.4	90	24	54.52	1,249.5	78	03	26	258	02	59	969.9
									121	31	43	301	30	53	Rogers 1,965.4

TABLE 4a.—*Geographical positions of tertiary points north of Keokuk, Iowa*—Continued.

[Referred to Cairo Astronomical Post.]

Name of station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
⊡ 1I^{3}	42	15	54.96	1,695.8	90	25	35.92	823.2	149	23	51	329	23	29	△ Rogers	1,427.2
									261	18	24	81	20	22	△ Blanding	4,066.2
									203	48	42				△ Wise	6,224.6
P. B. M. 305–306	42	15	49.52	1,528.0	90	25	32.02	733.8								
⊡ 1I$^{4}_{A}$	42	17	45.38	1,400.2	90	24	43.93	1,006.2	119	43	40	299	43	18	⊡ 1I$^{4}_{A}$	863.5
⊡ 1I$^{4}_{4}$	42	17	59.26	1,828.5	90	25	16.67	381.9	124	22	59	304	22	27	⊡ 1I$^{4}_{4}$	1,322.9
									24	08	13	204	07	39	△ Rogers	2,856.5
⊡ 1I^{4}	42	18	23.47	724.2	90	26	04.33	99.2	91	34	41	271	34	06	⊡ 1I^{4}	1,187.8
									310	20	42				△ Blanding	6,128.0
									1	17	38				△ Rogers	3,354.7
⊡ 1I$^{5}_{4}$	42	18	24.52	756.6	90	26	56.17	1,286.6	256	02	59	76	05	07	△ Wise	4,483.0
									341	49	05	161	49	38	△ Rogers	3,564.3
⊡ 1I^{6}	42	21	34.07	1,051.3	90	25	47.83	1,094.5	63	02	24	243	01	55	⊡ 1I^{6}	1,122.0
⊡ 1I^{8}	42	21	17.58	542.4	90	26	31.52	721.3	63	04	08	243	03	50	⊡ 1I^{8}	690.1
⊡ 1I^{8}	42	21	07.45	229.9	90	26	58.40	1,336.7	311	52	36	131	54	45	△ Wise	5,911.7
⊡ 1I^{8}	42	23	38.34	1,183.0	90	28	23.97	548.2	38	20	04	218	19	47	⊡ 1I^{8}	884.0
⊡ 1I^{8}	42	23	15.87	489.7	90	28	47.94	1,096.6	333	49	08	153	50	25	△ Smith	5,917.6
									105	05	06	285	03	33	△ Gordons Ferry	3,272.7
									38	04	48	218	04	31	⊡ 1I^{8}	965.8
⊡ 1I^{8}	42	22	51.23	1,580.8	90	29	13.97	319.6								
⊡ 1I^{7}	42	25	20.24	624.5	90	31	16.93	387.0	355	15	25	175	15	32	△ Gordons Ferry	2,996.7
									33	11	17	218	10	45	⊡ 1I^{7}	1,983.0
⊡ 1I^{7}	42	24	26.46	816.4	90	32	04.40	100.6								
⊡ 1I^{8}	42	26	51.60	1,592.2	90	34	05.04	115.2	355	28	32	175	28	42	△ Hubbard	4,550.1
									23	14	31				△ Iowa Spire	
									112	52	52				△ Mothers Convent	
⊡ 1I^{9}	42	25	52.89	1,632.0	90	35	16.03	366.4								
⊡ 1I^{2}	42	28	27.04	834.3	90	36	55.04	1,257.4	36	43	02	216	42	27	⊡ 1I^{2}	1,980.2
									52	57	12	232	56	23	△ Catfish	2,085.2
									96	03	21	276	01	40	△ Convent	3,456.5
									40	38	20				△ Lower Base	
									91	59	57				△ Mothers Convent	
⊡ 1I^{2}	42	27	35.43	1,093.2	90	37	47.01	1,074.0	216	07	22	36	07	52	△ Lower Base	1 727.7
									147	48	39				△ Court-House	
									149	52	07				△ St. Mary's Spire	
⊡ 1I^{2}	42	30	31.60	975.1	90	38	18.54	423.2	104	30	40	284	29	44	⊡ 1I^{2}	1,951.7
									206	03	21	26	04	02	△ Freese	3,160.7
									84	35	23				△ Dubuque	2,908.0
									50	27	20				△ Boundary Stone	112.0
									68	12	13				△ Court-House	
									87	06	33				△ St. Mary's Spire	

⊡ 1-3	42	30	47.44	1,463.8	90	39	41.31	943.0	52	47	14	232	46	45	ⓐ Dubuque	1,262.4
									234	20	24				ⓐ Freese	4,033.4
									11	13	01				ⓐ Court-House	
									38	03	23				ⓐ St. Mary's Spire	
⊡ 1½1	42	33	20.61	635.9	90	38	08.33	190.0	67	24	00	247	22	59	ⓐ Schubert	2,477.2
									334	04	01	151	04	36	ⓐ Freese	2,641.8
⊡ 1⅝1	42	32	54.91	1,694.3	90	38	39.41	899.2	47	11	04	227	10	47	⊡ 1¾1	804.4
									310	19	24	130	20	20	ⓐ Freese	2,445.6
									84	14	29	264	13	43	ⓐ Schubert	1,580.0
⊡ 1¾1	42	32	37.19	1,147.5	90	39	05.27	120.2	292	52	29				ⓐ Freese	2,064.3
									215	44	27				Flag pole	
⊡ 1⅞2	42	35	30.66	946.0	90	39	49.50	1,128.6	109	53	52	289	53	14	⊡ 1¾2	1,371.4
									95	30	07	275	28	51	⊡ 1⅞2	2,569.5
⊡ 1⅝2	42	35	45.78	1,412.6	90	40	46.06	1,050.0								
⊡ 1½2	42	35	38.63	1,192.0	90	41	41.68	950.2	296	53	06	116	54	28	ⓐ Fenley	3,096.3
⊡ 1⅜2	42	38	45.70	1,410.1	90	41	27.90	635.6	314	45	43	134	46	05	ⓐ Platte River	1,039.7
⊡ 1¼2	42	38	05.25	162.0	90	42	09.37	213.5	50	53	09	230	52	53	⊡ 1⅛2	066.0
									105	17	01				Gable of House	
⊡ 1⅛3	42	37	51.63	1,593.1	90	42	32.05	730.3	161	47	53	341	47	16	ⓐ Potosi	4,031.2
									246	56	18				ⓐ Platte River	2,390.8
⊡ 1¼3	42	40	48.64	1,500.8	90	44	40.56	923.4	281	17	32				ⓐ Potosi	
									281	30	19				Stone Chimney	
⊡ 1⅜4	42	39	15.51	478.6	90	45	43.81	998.0	351	06	59	171	07	03	⊡ 1⅝3	909.7
⊡ 1¼4	42	38	46.38	1,431.1	90	45	37.64	857.4	234	11	39	54	13	07	ⓐ Potosi	3,658.9
									151	11	35	331	10	47	ⓐ Grant River	3,307.4
⊡ 1⅛4	42	40	37.29	1,150.6	90	48	58.55	1,333.1								
⊡ 1⅜5	42	39	54.62	1,685.3	90	48	54.49	1,240.9	34	13	23	214	13	07	ⓐ Rumple = 1¼5	965.8
									83	59	23				Gable of House	
⊡ 1⅛5	42	41	13.54	417.8	90	52	12.58	286.4	101	01	37	281	00	26	ⓐ Sparks	2,426.3
									358	54	07	178	54	10	ⓐ Holy Cross Spire	5,534.3
⊡ 1⅝5	42	40	29.19	900.7	90	52	35.77	814.6	16	45	04	196	44	57	⊡ 1¾5	774.0
									334	23	07	154	22	18	ⓐ Waupeton	868.1
⊡ 1⅜6	42	40	05.17	159.5	90	52	45.57	1,037.7								
⊡ 1⅞7	42	41	51.45	1,587.5	90	55	22.24	506.2	108	51	18	288	40	58	ⓐ Jaco	2,823.0
									39	12	59	219	12	16	ⓐ Buena Vista	2,318.7
									326	33	00				ⓐ Holy Cross Spire	
⊡ 1½7	42	41	18.39	567.4	90	55	59.32	1,350.6	28	33	31	208	33	17	⊡ 1⅝7	962.5
									38	40	54				ⓐ Buena Vista	
⊡ 1⅝7	42	40	50.99	1,573.4	90	56	19.54	444.9	250	18	02	70	19	39	ⓐ Sparks	3,441.6
									153	47	03	333	46	23	ⓐ Jaco	3,095.9
									113	04	57				ⓐ Buena Vista	
⊡ 1⅜8	42	42	11.12	343.1	90	59	20.93	476.4	214	15	07	34	15	22	ⓐ West Base = 1⅛8	846.2
									202	09	04				ⓐ Cassville Spire	
									177	33	39				Cassville Spire # 2	
⊡ 1⅝8	42	41	33.29	1,027.2	90	59	02.42	55.1								
⊡ 1⅛8	42	44	06.92	213.5	91	01	24.86	565.5	341	58	41	161	59	22	ⓐ Spring Lake	4,438.0
									315	38	26				Cupola of Barn	
⊡ 1⅝9	42	43	25.41	784.0	91	01	43.32	985.7	25	56	32	205	56	23	⊡ 1¾9	094.9
⊡ 1⅜9	42	43	05.16	159.2	91	01	56.69	1,289.9	20	36	52	200	36	45	⊡ 1¼9	038.9
⊡ 1⅜10	42	42	45.78	1,412.6	91	02	06.57	149.5								
⊡ 1½10	42	45	45.54	1,405.2	91	03	26.77	608.6	326	48	43				Milepost = 213	

TABLE 4a.—*Geographical positions of tertiary points north of Keokuk, Iowa*—Continued.

[Referred to Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
⊡ $^{18}_{0}$	42 44 54.20	1,672.4	91 04 45.39	1,032.3	31 51 18	211 51 09	⊡ $^{19}_{0}$	582.7
					113 14 21		◌ Klinehunt	
					157 32 51		△ Guttenberg Spire	
⊡ $^{18}_{5}$	42 44 38.16	1,177.5	91 04 58.91	1,339.7	163 49 27		△ Guttenberg Spire	
⊡ $^{18}_{A}$	42 48 01.68	51.8	91 04 28.31	643.3	125 06 10	335 04 38	◌ Esmer	3,741.3
					16 02 23	193 01 37	◌ Klinehunt	5,512.4
					41 36 23	221 35 26	△ Guttenberg Spire	2,859.2
⊡ $^{18}_{1}$	42 47 36.39	1,122.9	91 05 35.96	817.1	83 35 56	263 35 35	⊡ $^{19}_{1}$	713.4
					152 31 47	332 31 02	◌ Esmer	3,303.8
					26 36 06		Protestant Spire	
					15 30 06		Court House	
					14 53 26		△ Guttenberg Spire	
⊡ $^{18}_{4}$	42 47 33.81	1,043.2	91 06 07.16	162.7	208 17 10	28 18 18	◌ Glen Haven	4,779.1
					164 51 03		◌ Esmer	3,119.2
⊡ $^{18}_{2}$	42 50 09.07	279.9	91 04 28.75	652.9	111 24 46	291 23 57	⊡ $^{19}_{2}$	1,748.7
					117 26 02	297 24 23	◌ Jung	3,708.3
					178 54 20		◌ Sandy Creek	5,806.8
					59 44 43		◌ Esmer	
⊡ $^{18}_{3}$	42 50 29.76	918.3	91 05 40.43	918.3	166 20 53	16 21 39	◌ Sandy Creek	5,385.5
					92 46 23	272 46 01	⊡ $^{19}_{3}$	732.6
					306 22 30		◌ Glen Haven	
⊡ $^{18}_{4}$	42 52 30.90	953.4	91 06 12.66	287.5				
⊡ $^{18}_{1}$	42 53 18.99	586.0	91 05 21.34	484.3	86 05 34	266 04 14	◌ Langworthy	2,663.9
					272 53 24		◌ Sandy Creek	
					144 29 27		Bagley Depot	
⊡ $^{18}_{3}$	42 53 07.42	228.9	91 06 09.31	211.3	43 50 44	223 50 28	⊡ $^{19}_{3}$	795.0
					96 21 36		◌ Langworthy	
⊡ $^{18}_{5}$	42 52 48.84	1,507.0	91 06 33.58	762.0	252 09 32		◌ Sandy Creek	2,859.3
⊡ $^{18}_{1}$	42 55 07.09	218.8	91 07 17.00	385.6	312 26 10	132 28 01	◌ Sandy Creek	5,023.0
					0 32 20	180 32 19	◌ Langworthy	3,517.7
⊡ $^{18}_{2}$	42 54 46.46	1,433.6	91 08 39.83	903.4	47 15 47	227 15 29	⊡ $^{19}_{5}$	817.7
					358 37 47		Lower Mill Chy	
					26 34 17		Upper Mill Chy	
⊡ $^{18}_{3}$	42 54 28.47	878.5	91 09 06.30	142.9	313 32 24	133 33 37	◌ Langworthy	3,376.1
					239 35 49		◌ Bagley	2,864.9
					280 32 31		◌ Sandy Creek	
					320 20 23		Mill Chy	
⊡ $^{18}_{5}$	42 56 45.45	1,402.4	91 08 29.16	661.1	88 57 41	268 57 07	⊡ $^{19}_{A}$	1,137.0
					25 41 06	205 40 18	◌ Clayton	3,701.8
					127 32 57		◌ Peterson	3,123.3
⊡ $^{18}_{8}$	42 56 44.78	1,381.7	91 09 10.31	437.7	278 13 11		Warehouse Chy	

⊡ 122	42	56	24.92	768.9	91	10	17.26	391.4	297	42	17	117	44	20	(S) Bagley	4,608.5
									342	35	24	162	35	50	(S) Clayton	2,832.3
⊡ 120	43	00	47.15	1,455.1	91	07	53.47	1,210.8	356	53	38				(S) Wisconsin Point	
									158	48	23				Catholic school	
									160	20	10				Schoolhouse	
⊡ 126	43	00	13.92	429.6	91	09	23.47	531.6	66	21	36	246	21	18	⊡ 126	632.8
⊡ 125	42	00	05.70	175.9	91	09	49.06	1,111.2	298	20	55	118	31	19	(S) Wisconsin Point	3,151.7
⊡ 127	43	03	01.80	55.5	91	09	25.13	568.7	72	39	44	252	38	53	⊡ 127	1,775.2
									327	36	25				Jesuit College	
									310	36	40				Convent	
⊡ 13?	43	02	44.65	1,378.0	91	10	40.00	905.3	295	02	31				Jesuit College	
									272	46	56				Convent	
									247	20	06				Monument	

DESCRIPTIONS OF SECONDARY TRIANGULATION STATIONS FROM GORDONS FERRY, IOWA, TO PRAIRIE DU CHIEN, WIS., 1893.

(5) Gratiots Grove: Spike in top of stone set about 2 feet under ground. Center of triangle on cap on Mississippi River Commission triangulation pipe is centered over old geodetic point. Pipe is about 2 feet long and projects 4 inches above ground. Station is on high level ground, in grass field, near northwest corner of field, 22 meters south of north edge, and 45 meters east of west edge of field, about 600 meters north and 200 meters east of stone schoolhouse, situated at crossroads, 2¼ miles south of Shullsburg, Wis. Blazed oak, 21.3 meters north; blazed oak, 23.1 meters northwest. This station is one of the Coast Survey points.

(6) Heffernan: Tile and pipe on Illinois side, 1 meter east of fence on west side of north and south wagon road; 20 meters north of fence corner, which is 200 meters east of house on Heffernan farm; station is about one-half mile south of Galena and Dubuque wagon road.

(7) Hubbard: Tile and pipe on Iowa side, on cleared bluff opposite foot of "Nine Mile Island"; 2 meters west of north and south line between properties of Jacob Hubbard and Joe Hilkins, on land of Hubbard; about 82 meters north of road, and 74 meters north and 20 meters west of marble tombstone of Andrew J. Green, standing in cultivated field; 12-inch burr oak, 325° (mag.) 8 meters; 24-inch burr oak, 43 meters north on line of fence.

(8) Rickey: Tile and pipe on Illinois side, in line of north and south rail fence between cultivated field and timber; 12 meters north of southwest corner of timber, which extends eastwardly on the north side of the Dubuque and Galena wagon road; about 1¼ miles east of the wagon bridge over the Big Menomonee Creek.

(9) Gassman: Copper bolt in top of flat surface of exposed natural rock; about 10 meters west of east end of small open spot on top of hill near its east end; 5 meters north of rail fence and 3 meters south of crest of mound; about 6 miles below Dubuque, 1½ miles from river, and one-fourth mile south of residence of Albert Gassman. Station is on Iowa side.

(10) Catfish: Tile and pipe on Iowa side; on top of bluff in brush and scattering timber, 50 meters from river; about one-half mile below two-span bridge of Chicago, Milwaukee and St. Paul Railroad over Catfish Creek, 35 meters back from crest of bluff and 10 meters north of bank of ravine; 100 meters below the upper end of bluff.

(11) Lower Base: Tile and pipe on Illinois side, 3 meters east of west right of way fence on Illinois Central Railroad; on long curve 1½ miles below East Dubuque, 25 meters above mile post 248–183, and 60 meters below farm crossing.

(12) Upper base: Tile and pipe on Illinois side; 1 meter west of right of way fence on Illinois Central Railroad on long curve about one-half mile below East Dubuque, Ill. Stone barn on Dubuque and Galena road is directly opposite this station.

(13) Convent: Tile and pipe on Iowa side; on small projecting knoll 50 meters below north line of Mothers Convent grounds, 10 meters from face of bluff, and about 300 meters north of and across the road from convent.

(14) Cutler: Tile and pipe on Illinois side; in cultivated field 25 meters west of Mr. Cutler's house, 1½ miles east of East Dubuque, Ill., and 70 meters south of county road running east of East Dubuque.

(15) Dubuque: Tile and pipe in Dubuque, Iowa; on vacant lot on bluffs corner of Thomas and Rebecca streets, and one-half block north of Fourteenth street, on highest part of knoll. White oak tree 330°, 29 meters. Lot is being graded and station will probably soon be removed.

(16) Boundary Stone: Wedge-shaped stone, 2 feet high, on line between Illinois and Wisconsin; about three-fourths mile above Dubuque bridge; 5 meters above switch; 30 meters below two-story brick house; 2 meters from rail on river side of Chicago, Burlington and Northern Railroad.

(17) Freese: Tile and pipe on Wisconsin side; in cultivated field; on top of very high bare point just back of Chicago, Burlington and Northern Railroad, about 40 meters east of crest of bluff, 100 meters north of edge of timber in small ravine, and 25 meters south of fence along bank of gully.

(18) Schubert: Tile and pipe on Iowa side; on land of Mr. Schubert; 1½ miles from river on road leading back just below Eagle Point; on north side of road running diagonally across cultivated field to residence of Schubert. Station is about 30 meters from house.

(19) Fenley: Tile and pipe on Wisconsin side: in small clover field on property of Mr. Fenley; on top of bluff between two ravines, about opposite foot of Island 217; 20 meters east of edge of timber at crest of bluff, and 30 meters south of timber line. A large stone building stands near mouth of ravine below station.

(20) Maquoketa: Tile and pipe on Iowa side; on high ground on south side of east and west road, and 35 meters east of road running south; opposite residence of Mr.

Teebolt, and southeast from residence of Peter Nowman; 2 meters from wire fence n south side of wagon road to Dubuque.

△ Platte River: Tile and pipe on Wisconsin side; on top of high steep bluff, 2 meters west of wire fence along edge of timber; in cultivated field about 20 meters east of timber line at crest of bluff; about 10 meters above lower edge of field; about 2¼ miles above Platte River and 3 miles below Potosi Railroad station.

△ Spechts Ferry: Tile and pipe on Iowa side; on high knoll, about three-fourths mile back of Spechts Ferry, and one-fourth mile west of Spechts Ferry road, on land of Edward Specht, about 50 meters from his north line, and 150 meters south of small, one-room frame house on bluff; in cultivated field on edge of woods.

△ Sherrill's Mound: Near Sherrill's Mound post-office, Iowa; point was small sapling stake (old Coast Survey station); this stake is replaced by a flint stone 6 by 6 inches on top, and geodetic point is a cross in center of stone; station is 7 meters east of line fence, and on property of Fitzwitter; station is near center of prominence known as Sherrills Mound.

△ Potosi: Tile and pipe on Wisconsin side; on top of bluff, one-half meter from edge of field at crest of bluff back of Chicago, Burlington and Northern Railroad, and about 300 meters below railroad station, Potosi.

△ Kratz: Tile and pipe on Iowa side; on property of Mr. Kratz, in small open spot at crest of bluff, and just west of top of bank of wooded ravine; mouth of ravine is 40 meters above mile post 103–58 of Chicago, Milwaukee and St. Paul Railroad.

△ Grant River: Copper bolt in solid rock on second rocky cliff above where Grant River comes out of Wisconsin bluffs; on Wisconsin side, on bare rock cliff, about 10 feet wide, and nearly detached from bluffs; center one of five nails is 1.77 meters below station; nails are driven in large cedar stump, and are in line with station; blazed 24-inch white oak is about 30 meters directly back of station.

△ Rumpel: Tile and pipe on Iowa side; on south side of Chicago, Milwaukee and St. Paul Railroad track 6½ metres north of south right-of-way fence; on prominent high ridge running out from bluff opposite head of first tow head below foot of Hurricane Island. Station is about 6 meters from and 4½ meters higher than railroad track.

△ McCartney: Tile and pipe on Wisconsin side; in cultivated field, on bluff point wooded in front; 30 meters north of edge of field at top of bluff; 20 meters below head of ravine, the mouth of which is about 150 meters below the lower switch of the Chicago, Burlington and Northern Railroad siding at McCartney. Station is on property of Mr. Swartz. Blazed 12-inch walnut 28 meters southwest.

△ Waupeton: Copper bolt in natural rock at top of cut on bluff side of Chicago, Milwaukee and St. Paul Railroad; on Iowa side about one-half mile below Waupeton. A triangle is cut around bolt and the letters U. S. on lower vertical face. Station is 300 meters above Cameron water tank.

△ Sparks: Tile and pipe on Wisconsin side; on thinly wooded bluff point on property of Mr. Sparks. Station is 1½ meters east of 18-inch tree which was used as a center post, and about 50 meters back of top of first bluff below Chicago, Burlington and Northern Railroad bridge No. 180.

△ Buena Vista: Tile and pipe on Iowa side; on corner of bluff, on side, at top of rock ledge; at northeast corner of bluff above the first hollow below Buena Vista, Iowa.

△ Jaco: Tile and pipe on Wisconsin side, 1½ miles below Cassville, Wis.; in scattering oaks on top of bluff just below large ravine, and directly opposite railroad bridge over creek coming out of this ravine; about 400 meters back of Jaco Slough; blazed 25-inch oak 15 meters west; blazed 20-inch oak 10 meters south; blazed 10-inch oak 15 meters north.

△ Brown House: Copper bolt in center of exposed horizontal face (5 meters long) of natural rock ledge on Iowa side; at crest of bluff about 300 meters above solitary brown house. House is at corner of bluff on upper side of ravine just back of railroad and 1 mile above Buena Vista. Station is about 75 meters above upper fence corner of front yard of house and 30 meters in front of front fence of cultivated field.

△ East Base: Tile and pipe on Wisconsin side, at east end of Cassville base; in public road 6 meters south of south rail of Chicago, Burlington and Northern Railroad track, and about 3 meters east of west road fence; at road crossing 1½ miles below Cassville, Wis.

△ West Base: Tile and pipe on Wisconsin side, at west end of Cassville Base; 1½ meters north of south right-of-way fence of Chicago, Burlington and Northern Railroad; 50 meters below coal chute, and 1 meter south of prolonged line of south rail of tangent.

△ Spring Lake: Copper bolt in exposed rock on top of bluff point on Iowa side; bluff is above Chicago, Milwaukee and St. Paul Railroad bridge No. K208. Station is 1 meter back from crest of ridge.

△ Kirschbaum: Tile and pipe on Wisconsin side, about 2 miles from Cassville,

Wis., and one-half mile east of timber along bluff near river; in fence corner on north side of wagon road about one-fourth mile west of bend in said road. Station stands in slight bend in road and about 100 meters east of east end of timber on opposite side of road. This road leads from Upper Cassville through a narrow ravine back of Cassville sawmills.

△ Kline Hunt: Copper bolt in natural rock on Iowa side; on projecting rock point opposite Chicago, Milwaukee and St. Paul Railroad bridge K256; about 100 meters below corner of bluff on lower side of Kline Hunt Hollow; 1¼ miles below Guttenburg, Iowa. Station is 15 meters in front of northeast corner of cultivated field and 25 meters below rail fence. Blazed 6-inch oak, 8 meters southwest.

△ Spoden: Tile and pipe on Wisconsin side, 1½ meters east of fence on west side of north and south wagon road; 100 meters north of junction of roads; one-half mile south of Lombardy poplars; a vacant house and barn are in corner of field near station, and a 24-inch maple tree is 15 meters north of station and just west of fence. Road leading to station from Glen Haven branches south (at a point 1½ miles northwest of station and 1½ miles southeast of Glen Haven) from wagon road which leads to right, up prominent ravine in Glen Haven, Wis.

△ Esmer: Tile and pipe on Iowa side, 1 meter east of fence on east side of garden east of house occupied by Mr. Esmer; on west side of cultivated field, 250 meters back from crest of bluff and about opposite milepost 80–81 of Chicago, Milwaukee and St. Paul Railroad. Wagon road to Esmer's house is 50 meters below milepost.

△ Glen Haven: Tile and pipe on Wisconsin side on top of prominent point just above Glen Haven, just back of railroad, and 15 meters back from crest of bluff; 6-inch oak, 312° 10′, 2 meters; 10-inch oak, 355° 38′, 6 meters; 5 inch oak, 143° 33′, 7 meters.

△ Jung: Tile and pipe on Iowa side, 300 meters back from crest of bluff; about opposite Chicago, Milwaukee and St. Paul Railroad station; at corner of lane, 200 meters southwest of residence of John Jung.

△ Sandy Creek: Copper bolt in bowlder covered by pipe, on Wisconsin side; at top of bare bluff, which is highest ground in vicinity; 7 meters east of wire fence along west edge of timber, and 35 meters south of fence corner. This fence runs down face of bluff in line with wagon road running from road along foot of bluff to farmhouse. Station is about 1½ miles below Bagley, Wis., and 15 meters north of a point in line with a windmill and the third telegraph pole above Chicago, Burlington and Northern Railroad bridge No. 218.

△ Langworthy: Tile and pipe on Iowa side; on top of high, steep, narrow ridge back of Chicago, Milwaukee and St. Paul Railroad; about 1½ miles below Clayton, Iowa, and opposite head of willows on bar in mid stream.

△ Clayton: Tile and pipe on Iowa side; at upper corner of bluff, about 50 meters in front of edge of clearing at top, and directly back of signboard on railroad, 1 mile above Clayton depot. Blazed trees: 36-inch oak, 5 meters south; 30-inch oak, 6 meters east; 18-inch oak, 10 meters north.

△ Bagley: Tile and pipe on Wisconsin side, about 1 mile above Bagley; on narrow ridge bare in front and timbered on back slope; about 150 meters above lower point of ridge; about 8 meters in front of timber line, and about 300 meters below projecting rock point at high part of ridge. Station is opposite upper edge of Clayton, Iowa. Blazed trees: 10-inch oak, 15 meters northwest; 6-inch oak, 15 meters east.

△ Clark: Tile and pipe on Wisconsin side; on high ground, about 400 meters southeast of ravine which comes out of bluff one-fourth mile above Wyalusing, Wis.; in line of east and west fence forming boundary line of property of Clark; 1 meter east of corner of east and west fence and fence running south from northeast corner of orchard. Station is about 2½ miles northeast of Wyalusing and on road running diagonally across cultivated field.

△ Peterson: Tile and pipe on Iowa side, 2 meters west of and in open spot in sumach bushes which form dividing line between lands of Peterson and Miller; about 80 meters north of that corner of fence which is at corner of timber on bank of ravine; about 200 meters south of top of bank of main branch of ravine which enters bluff at Chicago, Milwaukee and St. Paul Railroad bridge K 374; about 250 meters above small island, in middle of slough back of and nearly one-half mile below head of island No. 176. Station is one-half mile back from river and 1,050 meters from small church.

△ Wisconsin Point: Tile and pipe on Wisconsin side; on top of ridge (highest ground in vicinity) opposite point about 300 meters below lower end of trestle south of Wisconsin River on Chicago, Burlington and Northern Railroad. Blazed trees: 16-inch oak, 12 meters south; 14-inch oak, 9 meters southeast; 12-inch oak, 20 meters northeast.

△ Drake: Tile and pipe on Iowa side, at east edge of cultivated field and west edge of timber, about one-half mile southwest of mouth of ravine at Pictured Rocks; 4 meters west of center of wagon road; 20 meters south of a wagon road running

west through field; 21 meters north of fence corner. Blazed trees: 12-inch oak, 7 meters east; 8-inch oak, 4 meters northeast.

△ Prairie du Chien: Tile and pipe in lower part of Prairie du Chien, Wis., about 200 meters east of Chicago, Burlington and Northern Railroad, and about 300 meters southeast of a 2-story stone schoolhouse; about 500 meters west of a cemetery and one-half mile east from river bank; 1 meter north of east and west fence on north side, and 1½ meters west of north and south fence on west side of wagon road.

△ North McGregor: Copper bolt in rock, and iron pipe, on Iowa side; at corner of bluff on upper side of ravine, 1 mile above North McGregor, Iowa.

△ South Base: Tile and pipe on Wisconsin side, in open ground in upper part of Prairie du Chien; about one-fourth mile back from river and 200 meters below east end of Chicago, Milwaukee and St. Paul Railroad bridge over Mississippi River; about 30 meters southwest of west end of footbridge over slough; 6 meters south of footpath and at foot of small slope; about one-fourth mile above Main street bridge over slough, at south end Prairie du Chien base line.

△ North Base: Tile and pipe on Wisconsin side; in grass field, 1,620 meters above △ south base; 15 meters east of small pond; 20 meters west of a ditch which is 10 meters west of a fence; about 45 meters south of bend in fence, and 100 meters north of another fence at south side of wagon road. Station is at north end of Prairie du Chien base line.

△ Dousman: Tile and pipe on Wisconsin side; in open ground, on very prominent point of bluff, about one-fourth mile above Mr. Dousman's house and 1½ miles above Chicago, Burlington and Northern Railroad depot, Prairie du Chien. Station is about at middle of lower slope of point.

PRECISE LEVELS.

In February, 1893, tile and pipe bench marks were set at intervals of about a mile along South Pass between Head of Passes and Port Eads. This was done by C. Donovan, U. S. assistant engineer in charge at Port Eads.

On arrival of *Patrol* at Head of Passes November 1, a precise level party under W. S. Williams was equipped, and leveling begun from the bench marks established by Assistant Engineer James A. Paige, January 20, 1893. The instruments used were Kern level No. 4 and rods 18 and 19.

The work was extended, without any special difficulty, to the outer end of the East Jetty. The water gauge at Port Eads, the tile and pipe bench marks, and the bench marks pertaining to the jetty works were connected with.

Pins were used for rod supports on all stretches between the Head of Passes to Port Eads, excepting where the ground was very soft. In such places long stakes were firmly driven and the rod held on a nail in the top of stake. The firm ground was found very near the bank of the Pass and the instrument was found to be quite stable and no settlement was noticeable between fore and back sights.

From Port Eads to the end of East Jetty the line was over soft ground, sandy beach, and sometimes on the jetty. The piling and driven stakes in the old jetty were used for rod supports. Although the conditions would be classed as unfavorable, yet the results are quite satisfactory.

At the Head of Passes old B. M. "Fire," established in December, 1875 by Lieut. Davis, was connected with. Its elevation above Cairo datum is 22.249 feet. The elevation of the zero of an old gauge near this bench mark is 19.244 feet. This old gauge was established in December, 1875, for Lieut. Davis by H. C. Collins, assistant engineer.

The elevation of the zero of the present U. S. engineer's gauge at Head of Passes is 19.125 feet above Cairo datum. This gauge was established by C. Donovan, assistant engineer, December 11, 1878. The gauge is self-registering.

At Port Eads a gauge was established August 14, 1875, on the west side of the river, for Lieut. Davis by O. D. Parmely, assistant engineer, and the zero referred to certain bench marks in the light-house.

On November 16, 1881, this gauge was replaced by a new one established by C. Donovan, assistant engineer. The zero of the new gauge was placed at same elevation as the old one and referred to the same bench marks. It is self-registering and the elevation of its zero as determined by precise levels is 17.733 feet above the Cairo datum. The precise levels closed on a bench mark at the sea end of the East Jetty on a column supporting the light-house. This seems to be an exceptionally good location for a self-registering tide gauge, and the bench mark left affords a ready connection with the line of precise levels northward.

The tile and pipe bench marks along South Pass had been set about nine months before their elevations were determined.

The changes in elevations due to defects in setting has therefore been eliminated, and the results obtained should prove valuable in the future in solving the larger problem of the supposed subsidence of the delta.

Tabulated results of this work and descriptions of bench marks are appended.

RESULTS OF PRECISE LEVELING ALONG SOUTH PASS, FROM HEAD OF PASSES, LOUISIANA, TO END OF JETTIES, NOVEMBER, 1893.

[W. S. Williams, leveler.]

NOTE.—In the tabulation of results the reductions have been made from the bench mark, B. M. in light-house at Head of Passes to B. M. J. at the end of the jetties. The B. M. in the Head of Passes Light-house is the starting point and its elevation is that given in the Report of the Mississippi River Commission for 1893, p. 3624, being 8.1438 meters referred to the Cairo datum plane. In these reductions 1 meter equals 3.2808693 feet.

Table giving value of instrumental constants.

Instrument.	Date of observation.	Dates to be used between.	Remarks.
	1893.		
Telescope No. 4	Dec. 2	During the season.	Value of P, in seconds, +6.126; correction in millimeters per meter, +0.0291.
Bubble No. 4	Nov. 17	do	Seconds in one division, 2.427; correction in millimeters per meter, 0.01153.
Rod XVIII	do	do	Distance from first gradient to foot of spur, 44 millimeters; A of rod, 56 millimeters.
Rod XIX	do	do	Do.

Level No. 4. Stadia interval for the season, 5.026^{mm} intercepted on rod = 1 meter.

In the following tabulation column 1 gives the consecutive bench marks in the order in which the various elevations were deduced.

Column 2 gives the distance of any bench mark under consideration from the starting point.

Column 3 gives the direction that each line was run.

Column 4 gives the difference in elevation between these two bench marks; also the mean difference.

Column 5 gives the residuals found by subtracting each result from the mean result.

Column 6 gives the probable error in the result for each stretch.

Column 7 gives the probable error for each bench mark when referred to the first bench mark or starting point.

Column 8 gives the elevation above the Cairo datum in meters.

Column 9 gives the elevation above the Cairo datum plane in feet.

In computing the probable error per kilometer (giving 0.76^{mm}) the theoretical assumption is that the various stretches are 1 kilometer in length. The average length of the stretches is 856 meters.

Results of precise leveling, Head of Passes, Louisiana, to end of jetties along South Pass, November 2, 1893, to November 17, 1893.

By W. S. Williams, leveler.

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.	
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*
B. M. in light-house							8.1438	26.719
B. M. in light-house to T. B. M. 1.	0.014	Dir	−1.1263	−0.1				
		Rev	−1.1265	+0.1				
			−1.1264		0.1	0.1	7.0174	23.023
T. B. M. 1 to P. B. M. 1 (J. A. P.)	0.060	Dir	−0.5132	+0.1				
		Rev	−0.5130	0.1				
			−0.5131		0.1	0.1	6.5043	21.340
T. B. M. 1 to P. B. M. 1 A (J. A. P).	0.060	Dir	+0.6940	+0.0				
		Rev	+0.6940	−0.0				
			+0.6940		0.0	0.1	7.7114	25.300
T. B. M. 1 to P. B. M. 2 (J. A. P.)	0.042	Dir	+0.9986	+0.2				
		Rev	+0.9981	−0.3				
			+0.9984		0.2	0.2	8.0158	26.299

Results of precise leveling, Head of Passes, Louisiana, to end of jetties along South Pass, November 2, 1893, to November 17, 1893—Continued.

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.	
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*
T. B. M. 1 to B. M. "Fire"	0.065	Dir	—0.2358	—0.1				
		Rev	—0.2360	+0.1				
			—0.2359		0.1	0.1	6.7815	22.249
T. B. M. 1 to T. B. M. 2	0.750	1 Dir	+0.2376	+3.2				
		1 Rev	+0.2334	—1.0				
		2 Dir	+0.2327	—1.7				
		2 Rev	+0.2338	—0.6				
			+0.2344		0.7	0.7	7.2518	23.792
T. B. M. 2 to T. B. M. 3	2.211	Dir	—0.2168	—1.4				
		Rev	—0.2197	+1.5				
			—0.2182		1.0	1.2	7.0336	23.076
T. B. M. 3 to P. B. M. 9	2.235	Dir	—0.8460	—0.0				
		Rev	—0.8460	+0.0				
			—0.8460		0.0	1.2	6.1876	20.301
T. B. M. 3 to P. B. M. 9 A	2.235	Dir	+0.3585	+0.1				
		Rev	+0.3582	—0.2				
			+0.3584		0.1	1.2	7.3920	24.252
T. B. M. 3 to T. B. M. 4	3.709	Dir	+0.1124	—1.8				
		Rev	+0.1160	+1.8				
			+0.1142		1.2	1.7	7.1478	23.451
T. B. M. 4 to P. B. M. 8	3.719	Dir	—0.9058	+0.2				
		Rev	—0.9055	—0.1				
			—0.9056		0.1	1.7	6.2422	20.480
T. B. M. 4 to P. B. M. 8 A	3.719	Dir	+0.3027	—0.1				
		Rev	+0.3028	+0.0				
			+0.3028		0.0	1.7	7.4506	24.444
T. B. M. 4 to T. B. M. 5	5.459	Dir	—0.0222	+0.4				
		Rev	—0.0213	—0.5				
			—0.0218		0.3	1.7	7.1260	23.380
T. B. M. 5 to T. B. M. 6	5.849	1 Dir	—0.0880	—2.1				
		1 Rev	—0.0907	+0.6				
		2 Dir	—0.0904	+0.3				
		2 Rev	—0.0913	+1.2				
			—0.0901		0.5	1.8	7.0359	23.084
T. B. M. 6 to P. B. M. 7	5.946	Dir	—0.8865	+0.4				
		Rev	—0.8857	—0.4				
			—0.8861		0.3	1.9	6.1498	20.177
T. B. M. 6 to P. B. M. 7 A	5.946	Dir	+0.3205	—0.1				
		Rev	+0.3207	+0.1				
			+0.3206		0.1	1.8	7.3565	24.136
T. B. M. 6 to T. B. M. 7	6.657	Dir	—0.1247	+0.5				
		Rev	—0.1238	—0.4				
			—0.1242		0.3	1.8	6.9117	22.677
T. B. M. 7 to T. B. M. 8	7.511	Dir	—0.0123	+1.0				
		Rev	—0.0103	—1.0				
			—0.0113		0.7	2.0	6.2004	22.639
T. B. M. 8 to P. B. M. 6	7.551	Dir	—0.7268	+0.2				
		Rev	—0.7263	—0.3				
			—0.7266		0.2	2.0	6.1738	20.255

Results of precise leveling, Head of Passes, Louisiana, to end of jetties along South Pass, November 2, 1893, to November 17, 1893—Continued.

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	v.	R.	Elevation above Cairo datum.	
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*
T. B. M. 8 to P. B. M. 6 A	7.551	Dir	+0.4795	−0.1				
		Rev	+0.4796	+0.0				
			+0.4796		0.0	2.0	7.3830	24.213
T. B. M. 8 to T. B. M. 9	8.319	Dir	−0.0727	+1.0				
		Rev	−0.0707	−1.0				
			−0.0717		0.7	2.1	6.8287	22.404
T. B. M. 9 to T. B. M. 10	9.079	Dir	+0.2851	+0.2				
		Rev	+0.2847	−0.2				
			+0.2849		0.1	2.1	7.1136	23.339
T. B. M. 10 to P. B. M. 5	9.092	Dir	−0.5318	−0.1				
		Rev	−0.5320	+0.1				
			−0.5319		0.1	2.1	6.5817	21.594
T. B. M. 10 to P. B. M. 5 A	9.092	Dir	+0.6710	+0.2				
		Rev	+0.6707	−0.1				
			+0.6708		0.1	2.1	7.7844	25.540
T. B. M. 10 to T. B. M. 11	9.971	Dir	−0.1565	−0.9				
		Rev	−0.1583	+0.9				
			−0.1574		0.6	2.2	6.9562	22.822
T. B. M. 11 to T. B. M. 12	10.747	Dir	−0.0270	+0.4				
		Rev	−0.0262	−0.4				
			−0.0266		0.3	2.2	6.9296	22.735
T. B. M. 12 to P. B. M. 4	10.760	Dir	−0.7846	−0.0				
		Rev	−0.7847	+0.1				
			−0.7846		0.0	2.2	6.1450	20.161
T. B. M. 12 to P. B. M. 4 A	10.760	Dir	+0.4200	−0.0				
		Rev	+0.4201	+0.1				
			+0.4200		0.0	2.2	7.3496	24.113
T. B. M. 12 to T. B. M. 13	11.895	Dir	+0.0878	+0.1				
		Rev	+0.0876	−0.1				
			+0.0877		0.1	2.2	7.0173	23.023
T. B. M. 13 to T. B. M. 14	12.363	Dir	−0.1561	−0.9				
		Rev	−0.1580	+1.0				
			−0.1570		0.6	2.3	6.8603	22.508
T. B. M. 14 to P. B. M. 3	12.379	Dir	−0.7117	+0.2				
		Rev	−0.7113	−0.2				
			−0.7115		0.1	2.3	6.1488	20.173
T. B. M. 14 to P. B. M. 3 A	12.379	Dir	+0.4902	−0.2				
		Rev	+0.4906	+0.2				
			+0.4904		0.1	2.3	7.3507	24.117
T. B. M. 14 to T. B. M. 15	13.981	Dir	−0.0282	+1.0				
		Rev	−0.0261	−1.1				
			−0.0272		0.7	2.4	6.8331	22.418
T. B. M. 15 to P. B. M. 2	14.001	Dir	−0.7469	−0.1				
		Rev	−0.7470	+0.0				
			−0.7470		0.0	2.4	6.0861	19.968
T. B. M. 15 to P. B. M. 2 A	14.001	Dir	+0.4592	−0.0				
		Rev	+0.4593	+0.1				
			+0.4592		0.0	2.4	7.2923	23.925

Results of precise leveling, Head of Passes, Louisiana, to end of jetties along South Pass, November 2, 1893, to November 17, 1893—Continued.

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.	
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*
T. B. M. 15 to T. B. M. 16	14.606	Dir	+0.0142	+1.2				
		Rev	+0.0119	—1.1				
			+0.0130		0.8	2.5	6.8461	22.461
T. B. M. 16 to T. B. M. 17	15.625	Dir	—0.0102	—2.1				
		Rev	—0.0144	+2.1				
			—0.0123		1.4	2.9	6.8388	22.421
T. B. M. 17 to T. B. M. 18	16.417	1 Dir	+0.0380	+1.6				
		1 Rev	+0.0339	—2.5				
		2 Dir	+0.0375	+1.1				
		2 Rev	+0.0361	—0.3				
			+0.0364		0.6	2.9	6.8702	22.540
T. B. M. 18 to T. B. M. 19	17.218	Dir	+0.3798	+1.2				
		Rev	+0.3773	—1.3				
			+0.3786		0.8	3.0	7.2488	23.782
T. B. M. 19 to T. B. M. 20	17.858	1 Dir	—0.0447	+3.5				
		1 Rev	—0.0425	+1.3				
		2 Dir	—0.0380	—3.2				
		2 Rev	—0.0393	—1.9				
			—0.0412		1.0	3.2	7.2076	23.647
T. B. M. 20 to B. M. X	17.891	Dir	—0.5333	—0.2				
		Rev	—0.5337	+0.2				
			—0.5335		0.1	3.2	6.6741	21.897
T. B. M. 20 to B. M. D	17.926	Dir	—0.4868	—0.3				
		Rev	—0.4874	+0.3				
			—0.4871		0.2	3.2	6.7205	22.049
T. B. M. 20 to 4-foot mark on gauge at Port Eads	17.893	Dir	—0.5838	+0.3				
		Rev	—0.5832	—0.3				
			—0.5835		0.2	3.2	6.6241	21.733
T. B. M. 19 to P. B. M. I	17.506	1 Dir	+0.0650	—0.6				
		1 Rev	+0.0672	+1.6				
		2 Dir	+0.0658	+0.2				
		2 Rev	+0.0643	—1.8				
			+0.0656		0.4	3.1	7.3144	23.998
P. B. M. I to T. B. M. 21	18.326	Dir	—0.4647	—0.9				
		Rev	—0.4665	+0.9				
			—0.4656		0.6	3.1	6.8488	22.470
T. B. M. 21 to T. B. M. 22	19.005	Dir	+0.2130	—0.8				
		Rev	+0.2145	+0.7				
			+0.2138		0.5	3.2	7.0626	23.171
T. B. M. 22 to T. B. M. 23	20.137	Dir	+0.1883	—2.3				
		Rev	+0.1929	+2.3				
			+0.1906		1.5	3.5	7.2532	23.797
T. B. M. 23 to T. B. M. 24	21.387	Dir	—0.5610	—0.6				
		Rev	—0.5622	+0.6				
			—0.5616		0.4	3.5	6.6916	21.954
P. B. M. J	21.409	Dir	+0.7486	+0.0				
		Rev	+0.7485	—0.1				
			+0.7486		0.0	3.5	7.4402	24.410

Probable error per kilometer is 0.76mm.

DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS BETWEEN THE HEAD OF THE PASSES AND THE END OF THE JETTIES, ALONG SOUTH PASS.

NOTE.—Elevations are given in meters and feet above Cairo datum plane. To reduce to mean Gulf level at Biloxi, Miss., subtract 21.26 feet (preliminary value) from the elevations here given. One meter equals 3.2808693 feet. The term "P. B. M." denotes a precise bench mark which is set with special care so as to be practically permanent. These bench marks were set in January, 1893, by Assistant Engineer C. Donovan. Precise levels were run over the line and elevations established in November, 1893. In most cases a P. B. M. consists of a vitrified tile 18 by 18 by 4 inches, in the center of which is set vertically with lead a ¾-inch copper bolt, the upper end being about flush with the upper surface of the tile. Surrounding the bolt on the surface of the tile is the inscription "Mississippi River Commission." This is buried in the ground from 18 to 40 inches beneath the surface, the depth varying with the nature of the material. On top of the tile a 4-inch wrought-iron gas pipe, 4 feet long, is set, concentric with the copper bolt; the lower end of the pipe which is expanded somewhat like a boiler tube, fitting in a circular groove molded in the tile. A cast iron cap fits over the top of the pipe, and is fastened thereto with bronze bolts. The elevation on the top of the cap is also determined. The structure has thus two bench marks. P. B. M. 9, for example, being the top of the copper bolt, and P. B. M. 9 A being the top of the cap on the pipe.

The term T. B. M. denotes a temporary bench mark whose elevation is as well determined as that of a P. B. M., but is not regarded permanent.

Bench mark in Head of Passes Light-House is a + cut in top brick in the northeast corner of Head of Passes Light-House foundation; is in the north end of brick farthest east, and about 1 meter above ground.

Elevation, 8.1438 meters. 26.719 feet.

P. B. M. 1 is a nail in block under northeast corner of log-bell tower at Head of Passes Light-House.

Elevation, 7.0174 meters. 23.023 feet.

B. M. "Fire." Established by Lieut. Davis, December 8, 1875, and is described as the westerly of two bricks, marked "Fire," in step of light-house foundation, west side, called foundation of astronomical station by Coast Survey.

B. M. "Fire" is 10 meters north of P. B. M. 1, and about 3 feet west of line of fence on west side of light-house yard, produced. It is the top of the outside one of two bricks, marked | Belo Fire. | Belo Fire. | in step of circular foundation of old light-house at Head of Passes, west side.

Elevation, 6.7815 meters. 22.249 feet.

P. B. M. 9 is a copper bolt in the center of a vitrified tile in the ground, 15 meters from right bank of South Pass, 1¼ miles below Head of Pass Light, 20 meters above cypress tree on bank marked with triangular blaze toward P. B. M.; 100 meters below old vacant house.

Elevation, 6.1876 meters. 20.301 feet.

P. B. M. 9 A is top of cap on pipe over P. B. M. 9, described above.

Elevation, 7.3920 meters. 24.252 feet.

P. B. M. 8 is a copper bolt in the center of a vitrified tile in the ground, 2¼ miles elow Head of Passes Light; 12 meters from right bank of South Pass; opposite ower end of willow grove on left bank, called Goat Island; 660 meters above △ tation.

Elevation, 6.2422 meters. 20.480 feet.

P. B. M. 8 A is top of cap on pipe over P. B. M. 8, described above.

Elevation, 7.4506 meters. 24.444 feet.

P. B. M. 7 is a copper bolt in the center of a vitrified tile in the ground; 7 miles above Port Eads; 10 meters from left bank of South Pass and 113 meters below telegraph pole 340.

Elevation, 6.1498 meters. 20.177 feet.

P. B. M. 7 A is the top of the cap on pipe over P. B. M. 7, described above.

Elevation, 7.3565 meters. 24.136 feet.

P. B. M. 6 is a copper bolt in the center of a vitrified tile in the ground; 6 miles above Port Eads; 16 meters from left bank of South Pass; 255 feet below telegraph pole 290.

Elevation, 6.1738 meters. 20.255 feet.

P. B. M. 6 A is top of cap on pipe over P. B. M. 6 described above.

Elevation, 7.3800 meters. 24.213 feet.

P. B. M. 5 is a copper bolt in the center of a vitrified tile in the ground; 5 miles above Port Eads; 100 feet above telegraph pole 240; 7 meters from left bank of South Pass.

Elevation, 6.5817 meters. 21.594 feet.

P. B. M. 5 A is top of cap on pipe over P. B. M. 5, described above.

Elevation, 7.7844 meters. 25.540 feet.

P. B. M. 4 is a copper bolt in the center of a vitrified tile in the ground; 4 miles

above Port Eads; 12 meters from left bank of South Pass, and 50 feet above telegraph pole 190.

Elevation, 6.1450 meters. 20.161 feet.

P. B. M. 4 A is the top of cap on pipe over P. B. M. 4, described above.

Elevation, 7.3496 meters. 24.113 feet.

P. B. M. 3 is a copper bolt in the center of a vitrified tile in the ground; 3 miles above Port Eads; 8 meters from the left bank of South Pass; behind first telegraph pole above telegraph pole 140.

Elevation, 6.1488 meters. 20.173 feet.

P. B. M. 3 A is the top of the cap on the pipe over P. B. M. 3, described above.

Elevation, 7.3507 meters. 24.117 feet.

P. B. M. 2 is a copper bolt in the center of a vitrified tile in the ground; 2 miles above Port Eads, 315 feet above telegraph pole 90; and 30 feet from left bank of South Pass.

Elevation, 6.0861 meters. 19.968 feet.

P. B. M. 2 A is the top of the cap on the pipe over P. B. M. 2, described above.

Elevation, 7.2923 meters. 23.925 feet.

P. B. M. 1 is the head of a boat spike in concrete block 1 foot square made on top of a pile in front of engineer's office at Port Eads. Established by C. Donovan, assistant engineer, and marked thus: $\left|\begin{array}{c} \text{APR. 1} \\ 1881 \\ \text{U. S.} \end{array}\right| \text{B. M.}$

Elevation, 7.3144 meters. 23.998 feet.

B. M. X is the head of a boat spike leaded into concrete block under column marked B. VIII; on new South Pass Light-House at Port Eads, built in 1881; the B. M. is on the west side of column 6 inches north of horizontal brace and 8 inches from iron pedestal; established in 1881 by C. Donovan, assistant engineer.

Elevation, 6.6741 meters. 21.897 feet.

Zero of U. S. engineer's gauge at Port Eads.

Elevation, 5.4049 meters. 17.733 feet.

M. B. D. is a copper tack leaded in top of brick pier at northeast corner of old South Pass Light-House foundation at Port Eads. The brick pier is 15 by 20 inches and about 1 foot above ground; established in 1875 on the brick, reestablished in 1881 and copper tack put in by C. Donovan, assistant engineer.

Elevation, 6.7205 meters. 22.049 feet.

P. B. M. J. is the horizontal furrow of cross on river side of middle column under east side of light-house at the end of the jetties at mouth of South Pass; the column is under fog bell and by platform for clock weights; $\frac{\text{U. S.}}{\text{P. B. M.}}$ cut on river side of column 0.35 meter above platform and marked with drab paint.

Elevation, 7.4402 meters. 24.410 feet.

TOPOGRAPHY AND HYDROGRAPHY.

Above Keokuk.—The field work of topography and hydrography was resumed on August 2, 1893, at stone line 114 near Montrose, where work of 1892 ended. Work was continued northward and closed on September 30, at stone line 132, 1 mile above Keithsburg, Ill., a distance by river of 63 miles.

The party was in charge of Assistant Engineer A. T. Morrow and was quartered on the steamer *Patrol* and survey boat *Illinois*. The methods pursued were the same as followed in previous work, instructions for which will be found in Annual Report Mississippi River Commission, 1891, p. 3481.

On the closing of the field work the surveyors returned to the office and completed their computations and field plats.

The number of square miles of topography done this season is 184; the number of square miles of hydrography 31, making an average of 4.1 square miles covered each working day during the field season.

Appended hereto are tables showing discrepancies in levels, elevation of high-water marks, the slope between successive stone lines from Keithsburg to Alton, and descriptions and elevations of bench marks.

Details of the field work will be found in report of Assistant Engineer A. T. Morrow. (Appendix 1 C.)

TABLE 5.—*Discrepancies between precise and ordinary levels.*

Between P. B. M's.	Distance.	Error.	Leveled by
	Miles.	*Feet.*	
Nos. 2 and 3	3½	0.08	F. G. Gray.
Nos. 3 and 7	9½	0.01	Do
Nos. 7 and 11	16	0.02	Do
Nos. 11 and 17	18½	0.09	M. I. Powers, jr.
Nos. 17 and 18	½	0.02	Do
Nos. 17 and 19	11½	0.03	M. I. Powers, jr., and W. H. Roper.
Nos. 19 and 20	½	0.01	W. H. Roper.

TABLE 6.—*Discrepancies between right and left bank levels.*

River crossing at—	Distance.	Discrepancy.	River crossing at—	Distance.	Discrepancy.
	Miles.	*Feet.*		*Miles.*	*Feet.*
Stone line 115	3	0.04	Stone line 125	3	0.02
117	3	0.03	126	3	0.09
118	3	0.06	127	3	0.19
119	3	0.10	128	3	0.09
120	3	0.05	129	3	0.13
121	3	0.14	130	3	0.05
122	3	0.08	131	3	0.01
123	3	0.09	132	3	0.09
124	3	0.03			

TABLE 7.—*Descriptions and elevations of high-water marks leveled to in season of 1893.*

[Elevations are referred to Memphis datum plane, which is 8.13 feet (preliminary value) below mean gulf level at Biloxi, Miss.]

Description.	Year.	Elevation.
		Feet.
On west side of Warsaw, Ill., flour mills, near center of building, cut in stone by U. S. engineers	1888	501.49
Do	1892	501.34
On pine gauge nailed to culvert just above Warsaw flour mills	1888	501.49
Do	1892	501.32
On east side of first warehouse above depot, Montrose, Iowa (private marks)	1851	521.45
Do	1880	518.20
Do	1881	519.05
Do	1888	519.89
On northwest corner ◇Jo◇ warehouse, Nauvoo, Ill	1881	521.01
Do	1890	521.27
On north abutment of Fort Madison bridge	1851	530.93
Do	1880	525.46
Do	1888	526.06
On northeast corner of flour mill, Dallas City, Ill	1851	532.95
Do	1892	530.12
On mouth of stone sewer below elevator, Burlington, Iowa	1888	536.37
On draw pier of railroad bridge at Burlington, Iowa	1851	537.06
Do	1888	535.63
Do	1892	535.80
Private marks in ◇Jo◇ warehouse, Burlington, Iowa	1880	534.38
Do	1881	535.27
Do	1888	535.95
Do	1892	536.28
On southwest corner of brick building, Second and Schuyler streets, Oquawka, Ill	1888	539.92
Do	1881	540.51
Do	1851	541.20
On A. B. Garard's fish house, Oquawka, Ill	1888	539.87
Do	1892	540.09
On southwest corner of brick warehouse, Keithsburg, Ill	1892	544.73
On frame residence, corner Second and Main streets, Keithsburg, Ill	1881	544.55
On laundry building, Second and Washington streets, Keithsburg, Ill. (not reliable)	1888	544.70
Do	1851	545.19

TABLE 8.—*Slope of water surface in Mississippi River between successive stone lines from Keithsburg, Ill., to Alton, Ill.*

[Elevations given in column 3 are in feet above the Memphis datum plane. Gulf level (preliminary value) is 8.13 feet above this plane. The values given for stone lines 132 to 114 were determined between August 2 and September 26, 1893, the stage on the Burlington gauge ranging from 510.9 to 512.6 feet.]

No. of stone line.	Location of line.	Elevation of water surface.	Total slope between lines.	Mid-stream distance between lines.	Slope per mile.
		Feet.	*Feet.*	*Miles.*	*Feet.*
132	1 mile above Keithsburg	532.23			
131	2 miles below Keithsburg	530.86	1.37	3.52	0.389
130	1⅞ miles above foot Huron Island	529.28	1.58	2.80	.564
129	Head Benton Island	527.51	1.77	3.34	.530
128	½ mile above Oquawka	526.26	1.25	3.34	.374
127	2¾ miles below Oquawka	524.76	1.50	3.25	.461
126	1½ miles above head Otter Island	524.03	.73	3.10	.236
125	$\frac{5}{16}$ mile above foot Otter Island	522.30	1.73	3.00	.577
124	1½ miles above Burlington bridge	520.44	1.86	2.75	.676
123	2½ miles below Burlington bridge	519.69	.75	3.63	.207
122	3½ miles above foot Burlington Island	518.35	1.34	2.75	.487
122	½ mile below foot Burlington Island	515.86	2.49	3.37	.740
120	$\frac{7}{16}$ mile above head Dallas Island	514.99	.87	3.00	.290
119	1 mile above head Lead Island	513.33	1.66	3.25	.511
118	½ mile above foot Dutchmans Island	511.93	1.40	2.87	.488
117	Head Niota Island	511.34	.59	2.64	.224
116	1½ miles below foot Niota Island	509.44	1.90	3.95	.481
115	1 mile above Montrose, Iowa	508.90	.54	3.00	.180
114	1⅞ miles below Montrose, Iowa	506.71	2.19	2.81	.780

[Elevations given in column 3 are in feet above the Memphis datum plane. Gulf level (preliminary value) is 8.13 feet above this plane. The values given for stone lines 114 to 95 were determined between September 1 and November 10, 1892. The stage on the Hannibal gauge for this period ranged from 2.2 to 4.8 feet.]

114	1¾ miles below Montrose, Iowa	507.31			
113	1 mile below upper end Des Moines Rapids Canal	504.98	2.33	3.06	0.761
112	1 mile above middle lock Des Moines Rapids Canal	497.34	7.64	3.12	2.449
111	At Keokuk bridge	488.28	9.06	3.62	2.503
110	$\frac{1}{16}$ mile above upper mouth Des Moines River	486.25	2.03	2.54	.799
109	Head Fox Island	485.12	1.13	3.20	.353
108	$\frac{5}{8}$ mile above head Hackley Island	483.86	1.26	3.12	.404
107	¾ mile above foot Island No. 408	482.74	1.12	3.32	.337
106	Head of Island No. 410	481.55	1.19	2.87	.415
105	½ mile above foot Tully Island	479.80	1.75	3.37	.519
104	At Canton, Mo	479.40	.40	3.28	.122
103	⅝ mile above head Shandrew Island	477.46	1.94	2.88	.674
102	At landing, La Grange, Mo	475.38	2.08	3.25	.640
101	$\frac{3}{4}$ mile above mouth Canton Chute	472.29	3.09	3.28	.942
100	1¼ miles above Quincy Railroad bridge	470.15	2.14	3.16	.677
99	At House of Correction, Quincy, Ill	468.87	1.28	3.28	.390
98	⅝ mile below head Ward Island	467.41	1.46	3.10	.471
97	¾ mile below mouth South River	466.21	1.20	2.75	.436
96	$\frac{7}{16}$ miles below foot Island No. 436	464.48	1.73	3.94	.439
95	⅜ mile below head Armstrong Island	462.60	1.88	2.35	.800

TABLE 8.—*Slope of water surface in Mississippi River between successive stone lines from Keithsburg, Ill., to Alton, Ill.*—Continued.

[Elevations given in column 3 are in feet above the Memphis datum plane. Gulf level (preliminary value) is 8.13 feet above this plane. The values given for stone lines 95 to 61 were determined between August 4 and November 13, 1891. The stage on the Hannibal gauge for this period ranged from −0.1 to 4.2 feet.]

No. of stone line.	Location of line.	Elevation of water surface.	Total slope between lines.	Mid-stream distance between lines.	Slope per mile.
		Feet.	*Feet.*	*Miles.*	*Feet.*
95	½ mile below head of Armstrong Island	460.04			
94	At Hannibal railroad bridge	458.08	1.96	3.87	.506
93	At foot Kings Island	456.82	1.26	2.91	.433
92	1½ miles above depot, Saverton, Mo	455.88	.94	3.19	.294
91	⅜ mile below head of Cottel Island	454.70	1.18	2.94	.401
90	⅛ mile above head of Gilberts Island	454.02	.68	3.16	.215
89	¾ mile above Mundy Landing	452.05	1.97	3.47	.568
88	Upper end Cottonwood Island	449.97	2.08	3.25	.640
87	Center of South Fritz Island	448.02	1.95	2.85	.684
86	1½ miles above Louisiana bridge	445.64	2.38	4.41	.540
85	½ mile below railroad bridge, Buffalo Creek	444.70	.94	2.87	.328
84	Mouth of Little Calumet Creek	443.58	1.12	3.25	.345
83	½ mile above head Clarksville Island	442.09	1.49	3.23	.461
82	Center of Eagle Island	440.92	1.17	3.24	.361
81	Center of Coon Island	439.07	1.85	3.41	.542
80	Foot of McCoy Island	437.33	1.74	3.27	.532
79	½ mile below Howard Island	435.02	2.31	3.19	.724
78	1½ miles below Hamburg, Ill	434.24	.78	3.03	.257
77	½ mile below foot of Westport Island	432.31	1.93	3.07	.629
76	½ mile below Gilead Landing, Ill	430.08	2.23	3.21	.695
75	At Hogville, Ill	427.98	2.10	3.06	.686
75	....do	427.98			
74	½ mile below foot Turner Island	426.70	1.28	3.10	.413
73	At Cap Au Gris, Mo	424.56	2.14	2.91	.735
72	At Bond Hollow, ½ mile below head Cuiver Island	424.18	.38	3.07	.124
71	Foot of Cuiver Island	422.41	1.77	3.07	.577
70	Across Two Branch Island	420.82	1.59	3.98	.400
69	Foot of Apple Island	419.63	1.19	2.41	.494
68	⅛ mile above head of Iowa Island	418.46	1.17	3.04	.385
67	Across center of Squaw Island	416.56	1.90	3.19	.596
66	Through Upper Grafton, Ill	414.88	1.68	3.05	.551
65	½ mile above head of Slim Island	414.56	.32	2.15	.149
64	At Portage des Sioux, Mo	413.64	.92	3.09	.250
63	1 mile above mouth of Piasa Creek	413.05	.59	2.47	.239
62	¾ mile below foot Little Piasa Island	412.37	.68	3.24	.210
61	At upper end Alton, Ill	412.10	.27	2.98	.091

DESCRIPTION OF BENCH MARKS ABOVE KEOKUK, IOWA, AND THEIR ELEVATIONS IN FEET ABOVE THE MEMPHIS DATUM.

Stone line 114.—About half way between Nashville and Montrose, Iowa, across head of small island covered with willows.

1½ Tile and pipe between the river bank and public road directly in front of the residence of Charles Hummel and between an old stone culvert and the west corner of a hedge inclosing an orchard on the hillside. It is 14 meters from the river bank, and 8 meters from the wagon track of the public road at a point 13 meters south of where a small ravine crosses the road; also 27½ meters from corner of hedge and 18.7 meters from 8-inch hickory tree. Elevation: Cap on pipe, 530.26; bolt in tile, 526.23.

1¾ Tile and pipe on little hillock between the public road and the railroad on the section line running west from the river on the south line of Solferino farm. Measuring on the section line it is 61 meters from the river bank, 56.5 meters from the center of the road, and 43.7 meters from the center line of railroad; it is also 37 meters from a large arched stone culvert on railroad. Elevation: Cap on pipe, 534.40; bolt in tile, 530.39.

Mechanics Rock.—Large bowlder in bed of river about 200 meters above stone line 114, and 10 meters from right bank. In low water it projects about 2 feet above the surface. Elevation of top, 508.79.

Old B. M. Spike in east side of walnut tree 15 meters east of culvert No. B. 32 on St. Louis, Keokuk and North Western Railroad in lower part of Montrose, Iowa. Bench mark marked by blaze and No. 16 in white paint. Elevation, 519.50.

1 L. B. Nail in root of tree 20 meters from shore line in row of trees along fence 60 meters above Main street, Nauvoo, Ill. Elevation, 515.24.

P. B. M. 3 is at Montrose, Iowa. It is center of copper bolt leaded horizontally in upper foundation stone of brick store building on south corner of Main and Cedar streets. It is on the east side 3 feet from north corner marked U. S. P. B. M. Elevation, 537.23.

61 Mackenzie.—Spike in root of 30-inch tree in willow grove just above Montrose, Iowa, 125 meters below mouth of Jack Creek, 110 meters above upper warehouse in Montrose, and 15 meters from river bank. Marked with circular iron plate spiked to tree. Elevation, 514.13.

H. W., 1851, 1888, 1881, 1880, Montrose, Iowa. These marks are on east side of first warehouse above depot at Montrose, Iowa. Near center of building, marked with black paint. Elevation: 1851 = 521.45; 1888 = 519.89; 1881 = 519.05; 1880 = 518.20.

2 R. B. Spike in trunk of large elm tree 2 meters from bank 150 meters below a Government light; 600 meters below stone line 115; 230 meters above mouth of small slough. Elevation, 514.

59 Mackenzie.—Spike in trunk of three pronged maple tree, 10 meters north of B. M. $1\frac{1}{3}^{A}$, marked by a circular iron plate nailed to tree. Elevation, 515.40.

Stone line 115.—At Nauvoo, Ill.; in line of prolongation of Young street.

$1\frac{1}{2}^{B}$ Tile and pipe one-half meter north of fence on south side of Young street; 116 meters from river bank; to brick house, 262°, 130 meters; to southeast corner of hedge 251° 30′, 56 meters; to southwest corner of hedge 97° 30′, 88 meters. Direction of Young street, Nauvoo, Ill., = 262°. Elevation: Cap on pipe, 537.96; bolt in title, 533.96.

$1\frac{1}{3}^{B}$ Tile and pipe on the right bank of the river 11 meters from the bank in a cluster of large soft maple trees at the mouth of Excelsior Slough. A 20-inch soft maple is 325°, 4 meters; 36-inch cottonwood is 48°, 19 meters; 22-inch maple, 91°, 13.5 meters; 20-inch soft maple, 191°, 5.7 meters; 20-inch soft maple is 232° 30′, 7.5 meters. Elevation: Cap on pipe, 516.10; bolt in tile, 512.09.

$1\frac{1}{4}^{B}$ = ⓐ Sand Ridge. Tile and pipe about 1½ miles above Montrose, Iowa; on a sand ridge on west side of wagon road, 10 feet inside of fence, railroad adjoining wagon road on east side. Station is 300 meters below mile post 30, and about 300 meters above a small shanty near corner of hedge fence. Elevation: Cap on pipe, 553.68; bolt in tile.

2 L. B. Nail in root of lone 36-inch walnut tree, along fence 400 meters above where Young street, Nauvoo, comes out to the river, 50 meters above Government light, 60 meters above house. Elevation, 535.04.

Mackenzie.—Nail driven horizontally in base of rock foundation in northwest corner on west side of Diamond Jo warehouse at Nauvoo Landing, in upper part of Nauvoo, Ill. Elevation, 518.20.

H. W. 1890, 1881, Nauvoo, Ill. These marks are on north side near northwest corner of Diamond Jo warehouse; 1890 is scratch dug in mortar 3.7 feet above bottom of foundation; 1881 is paint mark directly below. Elevation: 1890 = 521.27; 1881 = 521.01.

3 R. B. Nail in root of 18-inch maple tree, on east side of Devils Island, 5 meters from shore, about three-fourths mile above foot of island, and 600 meters above and across the river from Diamond Jo warehouse in Nauvoo, Ill. Elevation, 515.20.

4 R. B. Nail in root of 30-inch pin oak tree 5 meters from east bank of Devils Island, across river and slightly below ⓐ Sherman; 100 meters below long bar and slough running into island. Elevation, 516.67.

Stone line 116.—One and one-half miles below head of Devils Island.

$1\frac{1}{2}^{B}$ Tile and pipe on the east side of river road, on line dividing the land of Kimball and Laubisheimer; one-fourth mile below north line of section 31 of Illinois land survey; 150 meters above an old lime kiln which stands on the river bank; it is 18 meters from the river bank; to 18-inch elm tree, 129°, 18.5 meters; to 9-inch hickory, 140°, 11.5 meters; to 24-inch red oak, 310°, 6.2 meters. Elevation: Cap on pipe, 539.27; bolt in tile, 535.27.

$1\frac{1}{3}^{B}$ Tile and pipe on Devils Island opposite B. M. $1\frac{1}{2}^{B}$; 22 meters from bank of river, midway between the shore and a small slough running parallel with the shore; to 21-inch willow tree, 330°, 7.2 meters; to 16-inch willow tree, 66°, 7.3 meters; to 16-inch willow tree, 138°, 8.5 meters; all marked with triangular blaze facing bench mark. Elevation: Cap on pipe, 517.70; bolt in tile, 513.70.

$1\frac{1}{4}^{B}$ Tile and pipe on Devils Island, 740 meters back of B. M. $1\frac{1}{3}^{B}$; on a small ridge between the pond and the overflowed ground back. Bearing of line between bench marks 3 and 4, 300° 30′; to 10-inch maple tree, 311°, 7.5 meters; to 24-inch elm, 35°, 10 meters; to 16-inch elm, 197°, 8 meters; all are marked with triangular blaze on side facing bench mark. Elevation: Cap on pipe, 518.38; bolt in tile, 514.39.

3 L. B. Nail in root of 36-inch cottonwood tree, 100 meters above B. M. $1\frac{1}{2}^{B}$; 35 meters from river bank, 250 meters below Government light. Elevation, 516.85.

4 L. B. Nail driven horizontally in foot of 15-inch ash tree, on main L. B. back of Niota Island. Tree standing alone at base of rock bluff. Elevation, 518.45.

5 L. B. Nail in 18-inch elm tree standing at foot of bluff, 30 meters from the water's

edge. Nail found in tree with old mark obliterated. It is evidently an old bench mark tree blazed. Elevation, 519.61.

6 L. B. Nail in root of 36-inch cottonwood at foot of bluff three-fourths of a mile below submerged dike at head of Niota Island, opposite foot of large sand bar attached to Niota Island. Elevation, 518.48.

58 Mackenzie.—Railroad spike in root of double maple tree 8 inches and 18 inches in diameter, on river side of Devils Island, 1¼ miles below its head; about 100 meters above B. M. $1\frac{6}{7}$; 350 meters below lower of two dikes on east side of Island marked with circular iron plate nailed to tree. Elevation, 516.39.

51 Mackenzie.—Spike in root of tree 8 meters from river shore of Devils Island; 450 meters below extreme head of island; 140 meters above Government light, marked with circular iron plate nailed to tree. Elevation, 516.86.

4 R. B. Top of north corner of stone pier of St. Louis, Keokuk and North Western Railroad water tank; 450 meters below depot in Fort Madison, Iowa; on second pier northwest of spout to tank. Elevation, 529.34.

P. B. M. 4 is top of copper bolt leaded vertically in top of west end of south abutment of Chicago, Burlington and Quincy Railway bridge over Painter Creek, 1 mile south of Viele Station, Iowa, marked U. S. P. B. M. Elevation, 550.09. Not connected with in 1893.

P. B. M. 5. Top of copper bolt leaded vertically in northeast corner of stone of middle pier of Chicago, Burlington and Quincy Railway bridge over Little Devils Creek, one-half mile below Viele Station, Iowa, marked U. S. P. B. M. Elevation, 544.16. Not connected with in 1893.

P. B. M. 6. Top of copper bolt leaded vertically in top of stone abutment of Chicago, Burlington and Quincy Railway bridge over Devils Creek, one-half mile north of Viele Station, Iowa, marked U. S. P. B. M. Elevation, 549.12. Not connected within 1893.

P. B. M. 7 is at Fort Madison, Iowa. It is top of copper bolt leaded vertically in the water table of the hotel Anteres, on Front street near the depot. It is near the center of the building on the south side, marked U. S. P. B. M. Elevation, 541.32.

City datum of Fort Madison is low water of 1864 (?) at the foot of Pine street. This is 31.48 feet below P. B. M. 7. Elevation, 509.84.

Stone line 117.—Lower part of Fort Madison and across head of Niota Island.

$1\frac{1}{2}^{1}$ Tile and pipe on the hillside 12 meters southeast of the center of the public road and 80 meters from the river bank; it is at the point where the bluffs turn back from the river, 125 meters north of △ Niota; to 10-inch red oak tree, 31° 30′, 17.5 meters; to 12-inch red oak, 254°, 16.2 meters; to 15-inch Jack oak, 180°, 9.7 meters; to B. M. $1\frac{1}{2}^{7}$, 148°, 00″. Elevation: Cap on pipe, 586.36; bolt in tile, 582.36.

$1\frac{1}{2}^{7}$ Tile and pipe on a sandy ridge which extends along the west bank of Niota Island to head of island, 240°, 143 meters; to north corner of little frame house, 68°, 69 meters; to water's edge north, 25 meters; to large soft maple tree containing bench mark of Maj. Mackenzie, 3°, 22 meters. Elevation: Cap on pipe, 524.11; bolt in tile, 520.09.

$1\frac{1}{2}^{7}$ Tile and pipe in a vacant lot belonging to Mr. Wilson in the southwest quarter of block inclosed by Spruce street on the west, Division street on the south, Locust street on the east, and Des Moines street on the north; in Fort Madison, Iowa. It is 1½ meters from the line of a lot west belonging to J. C. Atlee; it is 46.5 meters east of Spruce street, and 11 meters south of the alley running east and west through the block. Elevation: Cap on pipe, 534.88; bolt in tile, 530.87.

Mackenzie.—Spike in root of 48-inch maple tree on head of Niota Island, 22 meters south of B. M. $1\frac{1}{2}^{7}$; 100 meters above house. Elevation, 519.47.

7 L. B. Nail in root of 36-inch maple tree standing in bunch of willows and maples on sand bar, 800 meters above head of Niota Island, a little above point opposite Diamond Jo warehouse, at Fort Madison. Elevation, 517.

8 L. B. Nail in root of 12-inch maple tree, on top of bank at head of island, 200 meters below Fort Madison bridge. Elevation, 519.05.

9 L. B. Nail driven in sloping 12 by 12 inch timber, on north end of first pier of trestle work east of east stone pier of Fort Madison, Iowa, bridge. Elevation, 515.61.

10 L. B. Nail in root of 36-inch oak tree, on top of bank, 60 meters from water's edge, three-quarters mile above Fort Madison bridge, and about 200 meters below lower of two submerged dikes. Elevation, 525.

Mackenzie.—Spike in root of 48-inch cottonwood, on river bank, 20 meters from water's edge in low water, opposite foot of Dutchmans Island, and about 500 meters above upper of 2 submerged dikes on left bank. Elevation, 519.23.

Mackenzie.—Nail on land side of 48-inch lone cottonwood tree, 20 meters from river, on left bank, opposite center of Dutchmans Island, at the point where road past Appanooce school house comes out to river, marked by a circular iron plate nailed to tree. Elevation, 521.69.

Zero, Signal Service gauge, Fort Madison, Iowa.—It is a wooden gauge on the west end of draw pier to Fort Madison bridge. Elevation of zero, 509.44.

Zero, U. S. Engineers gauge.—This gauge is cut in the south side of the second stone pier from the Iowa end of the Fort Madison bridge. Elevation of zero, 509.33.

High water marks, 1880, 1888, 1851. Fort Madison, Iowa.—Cut in stone on west end of north abutment bridge. Elevation: 1880=525.46; 1888=526.06; 1851=530.93.

Stone line 118.—Across Dutchmans Island, a little below the center.

$1\frac{1}{8}$=△ *Appanooce.*—Tile and pipe about three-quarters of a mile from river on Illinois side, in cultivated field 20 meters above telegraph pole, on which is fastened the 234-mile board, Chicago, Santa Fe and California Railroad; and 30 meters west of west right of way fence, about 2 miles above Niota, Ill. Road crosses railroad about 300 meters above station. Elevation: Cap on pipe, 531.90; bolt in tile, 527.89.

$1\frac{1}{8}$ Tile and pipe at the northeast corner of the Appanooce school house yard, on the section line running south from the river and separating the property of Sturgeon on the east and Doolittle on the west; to northeast corner of the school house, 80°, 17.5 meters; to red oak tree 20 inches diameter, 321°, 8.5 meters; to 12-inch red oak tree, 43°, 3.7 meters. Elevation: Cap on pipe, 535.70; bolt in tile, 531.70.

$1\frac{1}{8}$ Tile and pipe about half way up the hillside, at a point 52 meters back of St. Louis, Keokuk and Northwestern Railroad and 101 meters above bridge 16 C; to 26-inch white oak tree, 214°, 3.6 meters; to 21-inch white oak tree, 337°, 2.9 meters; to 18-inch white oak tree, 118°, 7.5 meters. Elevation: Cap on pipe, 645.27; bolt in tile, 641.28.

11 L. B. Nail driven in the root of 15-inch black ash, 20 meters from water's edge, about 400 meters above stone line 118. Elevation, 519.12.

Mackenzie.—Spike in root of 36-inch lone oak tree on top of the bank on the roadside and 40 meters from the water's edge, opposite large willow bar in front of Lead Island, on left bank. Elevation, 527.42.

Mackenzie.—Spike in root of 48-inch cottonwood tree standing alone on river bank, 20 meters from water's edge at low water, on left bank opposite head of Lead Island and 200 meters above a stone quarry. Elevation, 520.82.

Mackenzie.—Spike in root of 36-inch ash tree, on top of bank 30 meters from water's edge at low water, on left bank 600 meters below stone line 119, opposite first dike above Lead Island. Elevation, 522.72.

5 R. B. Spike in top of north pile of dike behind Lead Island. Elevation, 514.49.

6 R. B. Spike in root of 36-inch double elm tree, on main bank 15 meters from shore, opposite head of Hog Island. The tree is the lower of a group of three large elms. Elevation, 520.27.

Stone line 119.—One-fourth mile below Pontoosac, Ill., where public road turns back from river.

$1\frac{1}{9}$ Tile and pipe on brow of hill back of Pontoosac, Ill., 75 meters east of the section line running south from the river; to 11-inch elm tree, 274°, 22 meters; to 9-inch elm tree, 104°, 28¼ meters; to corner of fence on section line, 80°, 75.2 meters. Elevation: Cap on pipe, 658.48; bolt in tile, 654.48.

$1\frac{1}{9}$ Tile and pipe 1 meter east of fence and 35.5 meters south of corner of fence where the public road turns south from the river along the section line, about one-fourth mile below Pontoosac, Ill. It is 70 meters from the river bank and 37 meters S. 20° W. of the northwest corner of osage orange hedge inclosing the field on the east side of the road. Elevation: Cap on pipe, 528.81; bolt in tile, 524.79.

$1\frac{1}{9}$ Tile and pipe on the Iowa shore, opposite Pontoosac, Ill. It is in a cluster of large soft maple trees west of a larger patch of willows, about 45 meters from the bank. It is between two long dikes, 500 meters above the lower and 200 meters below the upper dike; to maple tree 30 inches in diameter, 28°, 6.2 meters; to 32-inch maple tree, 190°, 6.3 meters; to 16-inch maple tree, 99°, 129 meters; to 12-inch Jack oak tree, 317°, 2.7 meters. Elevation: Cap on pipe, 522.17; bolt in tile, 518.19.

$1\frac{1}{9}$ Tile and pipe 807 meters back of B. M. $1\frac{1}{9}$ by the side of a wagon road in heavy timber 150 meters south of the outlet of Green Lake. The bearing of the line from B. M. $1\frac{1}{9}$ to B. M. $1\frac{1}{9}$ is 347° 30′; to 30-inch elm tree, 320°, 7.5 meters; to 36-inch elm tree, 58°, 13.2 meters; to 11-inch elm tree, 158°, 8 meters. Elevation: Cap on pipe, 523.60; bolt in tile, 519.59.

12 L. B. Nail in root of 30-inch elm tree on river bank, 60 meters from water's edge at low water; about three-fourths mile above Pontoosac, Ill. It is about 50 meters below a small bridge. Elevation, 520.70.

Mackenzie.—Spike in root of 24-inch oak tree on river side of road, 75 meters from water's edge, on Illinois bank about 275 meters below Sycamore street, in Dallas City, Ill. Elevation, 530.04.

Mackenzie.—In stone foundation on northeast corner of warehouse in Dallas City, Ill., opposite mill chimney. Elevation, 529.11.

High-water marks 1851, 1892. Dallas City, Ill.—On corner of flour mill in Dallas City, Ill. Elevation, 1851, 532.95; 1892, 530.12.

Mackenzie.—Spike in 24-inch lone ash tree on L. B., opposite foot of Thompsons Island, 50 meters from bank of slough. Elevation, 523.98.

Mackenzie.—Spike in willow tree on the west side of Thompsons Island, 300 meters above foot of island, 10 meters from bank. Elevation, 520.88.

7 R. B. Nail in root of 36-inch maple tree, 3 meters from shore, 100 meters below small dike, opposite foot of Dallas Island. Elevation, 520.21.

Stone line 120.—One-half mile above foot of Thompsons Island.

$1\frac{1}{4}^{Q}$ Tile and pipe on the section line running south from the river, a short distance east of Dallas City, Ill. It is about half way up the hillside, 143 meters from the center of the Chicago, Burlington and Quincy Railroad, and 189 meters from the center of the Atchison, Topeka and Santa Fe Railroad. Elevation: Cap on pipe, 621.28; bolt in tile, 617.29.

$1\frac{2}{3}^{Q}$ Tile and pipe on Thompsons Island, 30 meters from the north shore, approximately on line between $1\frac{1}{4}^{Q}$ and $1\frac{3}{4}^{Q}$; to small birch tree (blazed), 338°, 4 meters. Elevation: Cap on pipe, 523.02; bolt in tile, 519.01.

$1\frac{3}{4}^{Q}$ Tile and pipe on the section line running north from the river between the properties of Patterson on the east and Blakeley on the west. It is 35 meters from the shore, at the southeast corner of a cultivated field. No trees or fence near. Elevation: Cap on pipe, 524.97; bolt in tile, 520.98.

$1\frac{1}{4}^{Q}$ Tile and pipe on the bank of a small bayou on line of B. Ms. 1^{2Q} and $1\frac{3}{4}^{Q}$. A large pond, with an old levee on the north, is in line. Elevation: Cap on pipe, 521.76; bolt in tile, 517.75.

Mackenzie.—Spike in 36-inch elm tree on top of bank, 8 meters from top of bank; on north bank of Thompsons Island, 675 meters above stone line 120; 1 mile above foot of island. Elevation, 522.46.

Mackenzie.—Bolt in 30-inch elm tree, 10 meters from top of bank, opposite head of large willow bar and foot of Peels Island; on north bank of Thompsons Island. Elevation, 522.30.

13 L. B.-Nail in root of 15-inch willow tree on top of bank, 100 meters above Mackenzie bench mark. Elevation, 522.39.

Mackenzie.—Bolt in root of stump on top of bank, 1 mile below head of Thompsons Island; on left bank opposite head of first large bar above foot of Peels Island. Elevation, 523.44.

Mackenzie.—Bolt in root of 12-inch maple near head of Thompsons Island, 20 meters from water. Elevation, 524.31.

Stone line 121.—Foot of Burlington Island.

$1\frac{1}{4}^{1}$ Tile and pipe on the property of Schultz, at the center of section 32. It is 202°, 1.8 meters from the quarter-section stone, and 267°, 10.2 meters from a 7-inch maple tree (blazed). Elevation: Cap on pipe, 525.63; bolt in tile, 521.61.

$1\frac{3}{4}^{1}$ Tile and pipe on a narrow sandy ridge in woods on the channel side of Turkey Island, 5 meters from the top of bank; to 18-inch willow tree, 52° 30', 10 meters; to 20-inch willow, 147°, 5 meters. Elevation: Cap on pipe, 523.31; bolt in tile, 519.31.

$1\frac{2}{3}^{1}$ Tile and pipe in a small open space in the front of Peels Island opposite the foot of Burlington Island, 21 meters from the bank and 10.5 meters, 85°, from a 12-inch willow tree, marked with triangular blaze facing bench mark. Elevation: Cap on pipe, 527.17; bolt in tile, 523.16.

$1\frac{1}{4}^{1}$ Tile and pipe on a ridge on Peels Island, 554.5 meters back of B. M. $1\frac{3}{4}^{1}$; to 18 inch hickory, 352°, 5 meters; to 15-inch elm, 81°, 4 meters; to 24-inch sycamore, 188°, 4.3 meters. Elevation: Cap on pipe, 527.04; bolt in tile, 523.04.

14 L. B. Nail in root of tree on L. B. of Shokokon Slough, 20 meters from bank opposite foot of 2-mile island. Elevation, 523.96.

8 R. B. Nail in root of 15-inch willow, 5 meters from bank on south corner of timber on upper Twin Island. Elevation, 521.37.

9 R. B. Nail in root of 18-inch oak tree on the point of right bank, 1 mile above head of Lower Twin Island, opposite foot of large willow bar; this point is revetted. Elevation, 524.83.

Mackenzie.—Spike in root of large oak tree, 5 meters from bank; 200 meters above B. M. 9 R. B. Elevation, 525.98.

Stone line 122.—One mile below Patterson Station, Iowa; across head of Island No. 380, and the foot of a small island opposite.

$1\frac{1}{4}^{2}$ Tile and pipe on Burlington Island, 15 meters from east shore, opposite foot of 2-mile island. It is 165°, 18.3 meters, from a 15-inch ash tree; 253° 30', 9.2 meters, from a 30-inch elm; 70°, 10 meters, from a 22-inch elm; trees blazed Elevation: Cap on pipe, 525.93; bolt in tile, 521.93.

$1\frac{3}{4}^{2}$ Tile and pipe on Island No. 380, 60 meters from head and 17 meters from top of bank; to 41-inch elm tree, 148°, 7.4 meters; to 9-inch ash tree, 235°, 4.5 meters; trees blazed. Elevation: Cap on pipe, 527.37; bolt in tile, 523.36.

$1\frac{2}{3}^{2}$ Tile and pipe 25 meters from the shore of a slough passing behind a small island. It is in open pasture, back of which lies an extensive area of flat land cov-

ered with marsh grass and weeds. Elevation: Cap on pipe, 528.62; bolt in tile, 524.59.

$1\frac{3}{4}^2$ Tile and pipe in the north end of a clump of willows in the low land, 830 meters back of B. M. $1\frac{3}{2}^2$ and in line with B. Ms. $1\frac{3}{3}^2$ and $1\frac{3}{1}^2$; is about 100 meters back of a small slough running south and surrounded by tall marsh grass. Elevation: Cap on pipe, 526.25; bolt in tile, 522.20.

Mackenzie—Spike in root of 10-inch willow tree on Burlington Island, 15 meters above foot of island and 15 meters from shore. Elevation, 52.269.

15 L. B. Nail in root of 7-inch ash tree on top of left bank of Shokokon Slough, 115 meters above dike, behind 2-mile island. Elevation: 527.18.

16 L. B. Nail in root of willow tree, 50 meters from water's edge, on left bank of Shokokon Slough, three-fourths mile above head of 2-mile island, 150 meters above foot of mud bar extending into slough. Elevation, 524.21.

17 L. B. Nail in root of 8-inch willow, 40 meters from top of bank, opposite foot of willow bar on left bank of Shokokon Slough; on line of stone line 123. Elevation, 524.61.

10 R. B. On root of 36-inch maple tree, 5 meters from bank, on small island near right bank at stone line 122; 200 meters below head of island. Elevation, 525.95.

Mackenzie.—On 18-inch elm tree on right bank, 40 meters from shore; 100 meters above road leading down to Kemper Landing; no spike in tree. Elevation of center of circular iron plate, 530.98.

11 R. B. Nail in root of 18-inch elm tree, 30 meters from water's edge, near the point where the Chicago, Burlington and Quincy Railroad leaves the river bank, about 3 miles below Burlington, Iowa. Elevation, 526.29.

P. B. M. 9. Center of hole in copper bolt leaded horizontally in top of foundation stone of brick house of James Gibbs, 4 miles above Fort Madison, Iowa. It is on the south side, 3 feet from southeast corner. House stands about 150 meters west of Chicago, Burlington and Quincy Railroad track, marked U. S. P. B. M.; not connected with in 1893. Elevation, 552.79.

P. B. M. 10. Top of copper bolt leaded vertically in north end of east abutment of Chicago, Burlington and Quincy Railroad bridge over Skunk River; 9 miles north of Fort Madison, Iowa; not connected with in 1893. Elevation, 554.87.

P. B. M. 11 is on stone building formerly known as Patterson's grocery, now used as storehouse, 3¼ miles below Burlington, Iowa, on south side of Chicago, Burlington and Quincy Railroad. It is center of hole in copper bolt set horizontally on north side near northeast corner, 2½ feet from the ground, marked U. S. P. B. M. Elevation, 546.94.

B. M. Pat. It is point of preliminary location of ⓐ Patterson. As it could not be used as a secondary station, the △ tile was left in position and a bench-mark cap was placed on pipe. It is in a field 2 meters north of a hedge fence on hill near top, abreast the 4-mile post of Chicago, Burlington and Quincy Railroad. A 2-story stone house with red roof is on slope of hill about 100 meters from stone. Elevation: Cap on pipe, 649.48; bolt in tile, 645.51.

Mackenzie.—Circular iron plate nailed to railroad tie erected in ground 4 meters west of railroad track at stone line 123 on right bank. Elevation, 541.64.

Stone line 123.—At the 3-mile post on the Chicago, Burlington and Quincy Railroad.

$1\frac{3}{1}^2$ Tile and pipe in the interior of Burlington Island, 560 meters back of B. M. $1\frac{3}{2}^2$; on the east side of an old wagon road; to 25-inch elm, 184°, 13 meters; to 18-inch white oak, 248°, 10 meters. Elevation: Cap on pipe, 527.52; bolt in tile, 523.51.

$1\frac{3}{2}^2$ Tile and pipe on west shore of Burlington Island, on narrow ridge 5 meters from shore; to 12-inch willow, 336°, 3 meters; to 15-inch willow tree, 29° 30′, 3 meters; to 15-inch willow tree, 121° 30′, .07 meter. Elevation: Cap on pipe, 527.75; bolt in tile, 523.81.

$1\frac{3}{4}^2$ Tile and pipe on the brow of the bluff above the 3-mile post on the railroad and in front of a dwelling house; to a 6-inch hickory, 308°, 4.5 meters; to a 7-inch hickory, 128°, 4.8 meters; to an 8-inch oak, 186° 30′, 2.5 meters. Elevation: Cap on pipe, 657.80; bolt in tile, 653.78.

P. B. M. 12. Destroyed.

P. B. M. 13. Destroyed.

P. B. M. 14. Destroyed.

12 R. B. Nail in southeast corner of crib around west abutment of Burlington bridge. Elevation, 522.25.

13 R. B. Square □ cut in southeast corner of west abutment of Burlington bridge; stone is used as bridge seat and is in same course of masonry as those upon which the plate girder rests. Elevation, 542.68.

Burlington City B. M. 1.—Top of water table on northwest corner of Front and Valley streets. Elevation, 544.26.

Burlington City B. M. 2.—Top of stone door sill on the northeast corner of Main and Valley streets. Elevation, 545.

City datum, Burlington, Iowa.—The elevations of B. M. 1 and 2 above are 101.53 and 102.27, respectively, above the city datum of Burlington, Iowa. Elevation of city datum, 442.73.

Zero Signal Service gauge, Burlington, Iowa.—Wooden gauge inside of long pier of drawspan of Burlington bridge at lower end. Elevation of zero, 7.00.

Zero U. S. Engineers gauge, Burlington, Iowa.—Cut in east side of pier at west end of drawspan of Burlington bridge. Elevation of zero, 518.16.

Zero gauge, Burlington, Iowa.—Wooden gauge graduated to inches nailed to northeast corner of B. B. A. clubhouse. Elevation of zero, 518.77.

High-water marks, 1888, 1892, and 1851.—Burlington bridge, marked on lower side of round pier to drawspan by U. S. engineers. Elevations: 1888, 535.63; 1892, 535.80; 1851, 537.06.

High-water mark, 1888, Burlington, Iowa.—Cut in side of upper stone of mouth of sewer emptying just below elevator. Elevation, 536.37.

High-water marks, 1880, 1881, 1888, 1892, 1892, Burlington, Iowa.—These are private marks in Diamond Jo warehouse; the two 1892 marks are on different parts of the warehouse. Elevation: 1880, 534.38; 1881, 535.27; 1888, 535.95; 1892, 536.28; 1892, 536.18.

Stone line 124.—Upper part of Burlington, Iowa.

$1\frac{1}{4}$ Tile and pipe on a ridge in the woods, 630.9 meters back of B. M. $1\frac{1}{4}$, nearly on line with B. Ms. $1\frac{1}{3}$ and $1\frac{1}{3}$; to 30-inch cottonwood, 314°, 4.7 meters; to 8-inch locust, 148° 30′, 7.8 meters; to 18-inch elm, 48° 30′, 3.2 meters. Elevation: Cap on pipe, 530.94; bolt in tile, 526.94.

$1\frac{2}{3}$ Tile and pipe on a sandy ridge, 25 meters from the water's edge, at the old warehouse levee, about 60 meters below the ferry landing, and about 120 meters from the old sawmill. Elevation: Cap on pipe, 532.11; bolt in tile, 528.12.

$1\frac{3}{4}$ Tile and pipe on the brow of the bluff, at the corner of the lots of Mr. Churchill and Mrs. Foote, about 50 meters north of the tall chimney of the waterworks engine house. Elevation: Cap on pipe, 644.44, bolt in tile, 640.42.

Mackenzie.—On tree on river side of road along top of left bank, opposite Burlington, Iowa, and 300 meters above ferry landing. No spike in tree, so center of bolt in center of iron plate was taken. Elevation, 530.02.

P. B. M. 15. Destroyed.

Mackenzie.—Center of bolt in center of iron plate on 36-inch elm tree on top of left bank, 1 mile above ferry landing, opposite Burlington, 75 meters below end of short dike, 100 meters above house near river. Elevation, 531.67.

Mackenzie.—Center of bolt in center of iron plate on 15-inch elm tree, 20 meters from bank, 500 meters above point on left bank, opposite foot of Rush Island; 150 meters below dike. Elevation, 532.24.

Mackenzie.—Center of bolt in center of iron plate on 15-inch ash tree, on left bank, in open timber, 15 meters above a short dike opposite upper portion of Rush Island. Elevation, 532.96.

14 R. B. Nail in root of 36-inch elm tree, 2 meters from bank in mouth of small slough just above sawmill, opposite foot of O'Connell Island. Elevation, 527.76.

15 R. B. Nail in root of 6-inch willow tree, 6 meters from bank of O'Connell Slough, 600 meters above mouth of Flint Creek, and 200 meters below point where wagon road leaves bank of slough in clump of six small willows. Elevation, 528.62.

16 R. B. Spike in root of 8-inch birch tree, 10 meters from bank of O'Connell slough, 700 meters below point opposite head of O'Connell Island, opposite head of dry pond on main bank, having outlet 700 meters below. Elevation, 530.08.

Stone line 125.—Foot of Otter Island.

$1\frac{1}{2}$ Tile and pipe near large swamp, 626 meters back of B. M. $1\frac{1}{2}$, to 15-inch cottonwood, 46°, 1.3 meters; to 18-inch elm, 135° 30′, 8 meters; to 30-inch elm, 292°, 10.2 meters. Elevation: Cap on pipe, 530.58; bolt in tile, 526.57.

$1\frac{2}{3}$ Tile and pipe at the head of the riprap, 14 meters from the water's edge, to 15-inch black oak, 303°, 6.5 meters; to 24-inch elm, 12°, 11.5 meters. Elevation: Cap on pipe, 531.28; bolt in tile, 527.27.

$1\frac{2}{3}$ Tile and pipe 13 meters west of a small slough on Otter Island, 400 meters above foot of island and 100 meters from east side of island; to 18-inch cottonwood, 65°, 7.4 meters; to 15-inch cottonwood, 176° 30′, 6 meters. Elevation: Cap on pipe, 529.82; bolt in tile, 525.84.

$1\frac{2}{4}$ Tile and pipe on O'Connell Island, 8 meters from east shore, 250 meters above a point opposite head of Rush Island, to 28-inch maple, 149°, 5.6 meters; to 9-inch maple, 232° 30′, 8.9 meters; to 15-inch maple, 301°, 7.2 meters. Elevation: Cap on pipe, 530.36; bolt in tile, 526.36.

18 L. B. Nail in root of 15-inch birch tree opposite upper end of Otter Island, 75 meters back from top of bank, in upper edge of triangular grass field, on fence line, 200 meters above house. Elevation, 532.89.

17 R. B. Nail in the root of 36-inch elm tree, 5 meters from bank, on mainland 200 meters above head of O'Connell Island. Elevation, 530.67.

18 R. B. Nail in root of 8-inch willow opposite head of Otter tow-head, in lower end of bunch of willows in front of dry slough. Elevation, 529.58.

Stone line 126.—Foot of Island 371, mouth of Swif' Slough.

$1\frac{5}{6}$ Tile and pipe 489 meters back of B. M. $1\frac{5}{6}$, on high ridge about 100 meters from the Henderson River, to 8-inch black-oak tree, 54° 30′, 5.5 meters; to 20-inch ash, 284°, 4.6 meters; to 10-inch ash, 198°, 4.5 meters. Elevation: Cap on pipe, 532.80; bolt in tile, 528.79.

$1\frac{5}{6}$ Tile and pipe on west bank of swale, 102 meters back from bank of slough, in heavy timber, to 18-inch birch, 150° 30′, 6 meters; to 24-inch elm, 218° 25′, 8 meters; to 12-inch oak, 5°, 4.5 meters. Elevation: Cap on pipe, 531.07; bolt in tile, 527.05.

$1\frac{5}{6}$ Tile and pipe in the midst of a group of large maples 10 meters from the shore, opposite the foot of Island 371, to 20-inch maple, 158°, 4.6 meters; to 16-inch maple, 237°, 7.3 meters; to 22-inch maple, 311° 30′, 6 meters. Elevation: Cap on pipe, 532.10; bolt in tile, 528.10.

$1\frac{5}{6}$ Tile and pipe at the back side of a cultivated field 666.8 meters back of B. M. $1\frac{5}{6}$, and about 200 meters east of house, to 10-inch locust, 220°, 7.9 meters; to 6-inch maple, 80°, 13.5 meters. Elevation: Cap on pipe, 533.50; bolt in tile, 529.49.

19 L. B. Nail in 10-inch willow on edge of bank in clump on young willows, one-half mile above stone line 126, 200 meters below mouth of small slough. Elevation, 528.35.

20 L. B. Nail in root of a 10-inch willow on west edge of a dry pond 35 meters from bank of river, one-fourth mile above mouth of Henderson Slough, opposite foot of Island 368. Elevation, 528.66.

21 L. B. Nail in root of 36-inch maple tree on top of bank 50 meters above small slough or draw one-half mile above mouth of Henderson Slough. Elevation, 533.39.

Stone line 127.—Head of Island 368 and across center of Eagle Island.

$1\frac{7}{1}$ Tile and pipe on edge of slough 587 meters back of B. M. $1\frac{7}{1}$, to 10-inch black-oak tree, 265°, 2 meters; to 8-inch ash, 137°, 4.7 meters; to 10-inch ash, 0°, 4.5 meters. Elevation: Cap on pipe, 531.31; bolt in tile, 527.29.

$1\frac{7}{3}$ Tile and pipe 32 meters from the shore, opposite head of Island 368, to 27-inch elm, 86°, 14.5 meters; to 21-inch ash, 213°, 10.3 meters. Elevation: Cap on pipe, 535.01; bolt in tile, 531.

$1\frac{7}{3}$ Tile and pipe 8 meters from east shore of Eagle Island No. 367, opposite foot of Fernel Island, to 13-inch willow, 14°, 3.7 meters; to 20-inch willow, 159°, 7.5 meters; to 12-inch willow, 202°, 2.5 meters. Elevation: Cap on pipe, 531.66; bolt in tile, 527.65.

$1\frac{7}{4}$ Tile and pipe back of B. M. $1\frac{7}{3}$, on main bank, 10 meters from slough, to 7-inch maple, 27°, 3 meters; to 8-inch birch, 183°, 9.4 meters. Elevation: Cap on pipe, 532.23; bolt in tile, 528.21.

P. B. M. 16. Top of copper bolt leaded vertically in north end of west abutment of trestle No. 59, about $4\frac{1}{2}$ miles north of the east end of the Burlington bridge, on the line of the Chicago, Burlington and Quincy Railroad, marked U. S. P. B. M. Elevation, 538.59.

P. B. M. 17. Center of copper bolt in Robert Moir's brick store building, at Oquawka, Ill. It is leaded horizontally in stone pillar at southwest corner, about 2 feet above the water table. The building stands on the northwest corner of Schuyler and Second streets, and is also used for the Journal office. Marked U. S. P. B. M. Elevation, 543.06.

P. B. M. 18. On brick building on southeast corner of Third and Schuyler streets, Oquawka, Ill. It is center of hole in copper bolt set horizontally on west side of northwest corner 2.5 feet above the ground, marked U. S. P. B. M. Elevation, 554.91.

High-water marks, 1888, 1881, 1851, Oquawka, Ill.—These marks are on the southwest corner of brick building on Second and Schuyler streets, occupied by W. H. Phelps, hardware. Elevation: 1888=539.92; 1881=540.51; 1851=541.20.

High-water marks, 1888, 1893, Oquawka, Ill.—On fish house of A. B. Garard, west of railroad. Elevation: 1888=539.87; 1892=540.09.

19 R. B. Nail in root of 8-inch willow tree 5 meters from bank, in heavy clump of willows, 400 meters below point opposite head of Island 365. Elevation, 533.49.

Stone line 128.—One-half mile above Oquawka, Ill.

$1\frac{8}{3}$ Tile and pipe between the railroad and sand bluff, one-half mile above Oquawka, Ill., 20 meters from edge of bluff and 81 meters from the center of the Chicago, Burlington and Quincy Railroad track. Elevation: Cap on pipe, 573.45; bolt in tile, 569.44.

$1\frac{8}{3}$ Tile and pipe on Iowa shore, 10 meters from the river bank, 140 meters below a Government light, opposite upper end of Oquawka, Ill., to 30-inch maple tree, 218°, 11.7 meters. Elevation: Cap on pipe, 535.92; bolt in tile, 531.93.

$1\frac{8}{4}$ Tile and pipe on a small ridge, 674 meters back of $1\frac{8}{3}$, to 18-inch hickory, 222°, 4.3 meters; to 12-inch ash, 15°, 6.8 meters; to 20-inch elm, 125°, 6.6 meters. Elevation: Cap on pipe, 536.14; bolt in tile, 532.13.

22 L. B. Nail in root of 24-inch elm on bank of small slough, at foot of sand ridge, 700 meters above point where sand ridge comes out to river bank; about 1¼ miles above stone line 128. Elevation, 533.84.

20 R. B. Nail in root of 24-inch oak tree, 25 meters from bank, in lower edge of large clearing opposite lower part of Benton Island. Elevation, 537.12.

21 R. B. Nail in root of 40-inch cottonwood tree, standing alone in middle of large clearing, 15 meters from bank of river opposite center of Benton Island. Elevation, 537.64.

Stone line 129.—Head of Benton Island.

$1\frac{129}{1}$ Tile and pipe on top of a high sand ridge, about 40 meters from the shore, on the section line running east from the river. Elevation: Cap on pipe, 594.07; bolt in tile, 590.07.

$1\frac{129}{2}$ Tile and pipe on Benton Island, 15 meters from the head, to 18-inch cottonwood, 119°, 3.7 meters; to 24-inch cottonwood, 245° 30′, 16.2 meters. Elevation: Cap on pipe, 536.78; bolt in tile, 532.78.

$1\frac{129}{3}$ Tile and pipe on Iowa shore, 8 meters from the water's edge, 400 meters below foot of Johnson Island; to 12-inch ash, 194°, 5.7 meters; to 7-inch maple, 72°, 3.6 meters; to 18-inch elm, 293°, 10.2 meters. Elevation: Cap on pipe, 536.76; bolt in tile, 532.74.

$1\frac{129}{4}$ Tile and pipe on the edge of the prairie, 661 meters back of B. M. $1\frac{129}{3}$; to 8-inch birch, 232°, 22.6 meters; to 72-inch black oak, 304°, 24 meters. Elevation: Cap on pipe, 538.10; bolt in tile, 534.07.

23 L. B. Nail in 30-inch elm at top of bank in open timber, just above Fullerton's Landing, three-fourths mile below head of Johnson Island, one-fourth mile above house. Elevation, 536.31.

22 R. B. Nail in 12-inch maple tree, 30 meters from bank of river; on Cody Island, opposite the head of Johnson Island. Elevation, 535.97.

Stone line 130.—Across the foot of Island 360.

$1\frac{130}{1}$ Tile and pipe 693 meters back of B. M. $1\frac{130}{2}$ on the high gronnd between a pond and a swamp; to 36-inch black oak tree, 251°, 5 meters; to 30-inch black oak, 338°, 11 meters. Elevation: Cap on pipe, 536.75; bolt in tile, 532.76.

$1\frac{130}{2}$ Tile and pipe 18 meters from the shore, 500 meters below upper end of Benton Bay; to 34-inch elm, 206°, 1 meter; to 10-inch locust, 341° 30′, 9.1 meters; to 20-inch elm, 73°, 19.3 meters; to 20-inch elm, 87°, 18 meters. Elevation: Cap on pipe, 538.57; bolt in tile, 534.55.

$1\frac{130}{3}$ Tile and pipe on the lower end of Island 360, 20 meters from the bank of the main channel; to 30-inch elm, 94°, 8.2 meters. Elevation: Cap on pipe, 535.50; bolt in tile, 531.48.

$1\frac{130}{4}$ Tile and pipe 752 meters back of B. M. $1\frac{130}{3}$, on Huron Island; 13 meters from the east shore; to 18-inch ash, 57°, 4.5 meters; to 7-inch maple, 339°, 4 meters; to 15-inch elm, 221°, 7.6 meters. Elevation: Cap on pipe, 537.50; bolt in tile, 533.49.

24 L. B. Nail in root of 36-inch sycamore tree on river bank 500 meters below point where sand bluffs leave river bank; 3 miles below Keithsburg, Ill., opposite foot of large bar. Elevation, 535.68.

23 R. B. Nail in root of 20-inch cottonwood, 10 meters from bank; about 400 meters above head of Huron Island. Elevation, 537.67.

Stone line 131.—Foot of Island 357, about 1¼ miles below Keithsburg, Ill.

$1\frac{131}{1}$ Tile and pipe about 30 meters back of the sand bluff on the line dividing the properties of Willis on the north and Brattan on the south; to 12-inch hickory, 236°, 3 meters; to 8-inch hickory, 114°, 12 meters. Elevation: Cap on pipe, 574.03; bolt in tile, 570.03.

$1\frac{131}{2}$ Tile and pipe 20 meters from the shore, 900 meters above the head of Huron Island; to 18-inch elm, 322°, 16.5 meters; to 15 inch maple, 114°, 7.5 meters; to 18-inch elm, 182° 30′, 11.9 meters. Elevation: Cap on pipe, 540.12; bolt in tile, 536.10.

$1\frac{131}{3}$ Tile and pipe 704.5 meters back of B. M. $1\frac{131}{2}$, on line with B. Ms. $1\frac{132}{2}$ and $1\frac{131}{1}$; 125 meters back of a slough crossed by the line; to 18-inch birch, 80°, 4.9 meters; to 7-inch walnut, 355°, 4.1 meters; to 8-inch ash, 221°, 5 meters. Elevation: Cap on pipe, 539.70; bolt in tile, 535.67.

P. B. M. 19. On the brick building on the northwest corner of Main and Second streets, Keithsburg, Ill. It is top of copper bolt leaded vertically in stone step on the south side of the building, and marked U. S. P. B. M. The building is owned by Mr. Parsons, and is used as a furniture store. Elevation, 546.67.

P. B. M. 20. On steps of Mr. Rife's brick dwelling on the northwest corner of Main and Fifth streets, Keithsburg, Ill. It is top of copper bolt leaded vertically in the southwest corner of upper stone step on the south side of the house, and is not marked. Elevation, 556.59.

High-water mark, 1892, Keithsburg, Ill.—Nail driven in mortar in foundation on southwest corner of brick warehouse on the corner of Main and First streets. Elevation, 544.73.

High-water mark, 1881, Keithsburg, Ill.—Marked on northwest corner of small frame dwelling on Second and Main streets, Keithsburg. Elevation, 544.55.

High-water marks, 1888, 1851, Keithsburg, Ill.—On northwest corner of frame building, used for steam laundry, on corner of Second and Washington streets, Keithsburg, said to have been marked recently and not reliable. Elevation: 1888=544.70; 1851=545.19.

Zero, U. S. engineer gauge, Keithsburg, Ill.—Cut in west side of east pier of Keithsburg railway bridge. Zero, 529.90.

25. L. B. Nail in root of 24-inch leaning elm, 10 meters from bank, one-half mile above Keithsburg bridge, opposite head of Black Hawk Island. Elevation, 538.12.

26. L. B. Nail in root of 15-inch hackberry, about 8 meters from bank of river, on stone line 132. Elevation, 541.91.

27. L. B. Nail in root of 12-inch hickory, 20 meters from bank and 60 meters below 26 L. B. Elevation, 542.54.

24. R. B. Top of square cut stone set on bank 10 meters from water's edge; in front of cow yard just above house; about 200 meters below foot of Black Hawk Island. Elevation, 539.37.

Stone line 132.—About 1¼ miles above Keithsburg bridge.

1¼ Tile and pipe 735.7 meters back of B M. 1¼ and 10 meters in front of a large slough; to 10-inch ash, 241°, 5.2 meters; to 8-inch willow, 38°, 1.5 meters; to 8-inch birch, 285°, 7.4 meters. Elevation: Cap on pipe, 538.57; bolt in tile, 534.55.

1¼ Tile and pipe in a small cleared area; to 10-inch elm, 24.1 meters southwest; to 8-inch hickory, 16.7 meters northwest; bench mark is 15 meters from the shore. Elevation: Cap on pipe, 543.16; bolt in tile, 539.20.

1¼ Tile and pipe on right bank, 15 meters from the shore; to 24-inch elm, 201°, 6.7 meters; to 10-inch ash, 76°, 12 meters. Elevation: Cap on pipe, 541.41; bolt in tile, 537.42.

1¼ Tile and pipe, 755.5 meters back of B. M. 1¼; to 5-inch ash tree, 289° 30′, 2 meters; to 5-inch ash, 23°, 2.8 meters. Elevation: Cap on pipe, 541.14; bolt in tile, 537.12.

FIELD WORK FROM HEAD OF PASSES TO DONALDSONVILLE.

Work was begun at Head of Passes on November 2, 1893, and continued northward to Donaldsonville, a distance of 175 miles, where it joined the work of 1882. The field work included the surveys of a portion of Cubitts Gap, the Jump, Lake Borgne Canal, the city of New Orleans, Lake Ponchartrain, from Milneburg to Manchac Pass, through the Pass to Lake Maurepas, and along south shore of same to Amite River. The same force engaged on the survey above Keokuk was utilized in the work on the lower river, using the same outfit with the addition of a steam launch, *Dora*, which was used in sounding and transferring the parties to different portions of the work.

The launch was an important factor in the progress of the work, and by its use exceptionally good results were obtained in soundings.

The topography was extended to the swamps on either side of the river. From Head of Passes to New Orleans all of the work was completed as the party moved up. Above New Orleans particular stress was laid on finishing the soundings and the topography between the levees before the advent of high water.

The sounding crew therefore set the pace of the party and the topography was completed as far as practicable, leaving the back work and the lake work to be done after the soundings were finished to Donaldsonville, La. This was done on February 21, and on the 22d the party turned back to complete the lacking topography and shore lines of the lakes.

In this way the entire survey between the levees was made at a low stage of the water, and exceptionally good results were obtained while the battures were exposed and the current of the river rather moderate.

The soundings were made with a 20-pound lead in depths less than 100 feet, and for greater depths a 30-pound lead was used.

The bank lines proper and the details of the battures were carefully noted and located, all of which would have been impracticable during a high stage of the river.

The chief of party, Mr. A. T. Morrow, was taken sick with malarial fever early in February, and was totally disabled about March 1. Assistant Engineer J. A. Ockerson took personal charge of the party in the field on March 3.

The survey on the lakes was done during the month of March. Assistant Engineer George H. French, assisted by O. N. Axtell, was detailed to do this work. The party was quartered on the yacht *Folly*, chartered at West End for that purpose. The steam launch *Nancy* was also hired to aid in transporting the working parties from point to point.

The lake work was connected with the geodetic points along the river by means

of traverse lines carefully measured with a steel tape and repeated angles. The upper traverse line runs back from La Place above Bonnet Carre to Frenier on the Illinois Central Railroad, thence along this railroad to Manchac Pass. Much of the railroad line lies along near the shore of Lake Ponchartrain.

The distances along the lake shores were carefully read with stadia and the azimuth angles were repeated by two observers.

The lake work was completed on April 1.

On March 18 the work along the river was completed up to Bonnet Carre Point. The topographical party was then turned over to Assistant Engineer W. G. Comber, and Assistant J. A. Ockerson returned to his duties in the office at St. Louis.

The work was completed to Donaldsonville, La., on April 10, and the party was disbanded on the following day.

The steamer crew were ordered to St. Louis with *Patrol* and outfit.

The surveyors were also ordered to the St. Louis office to complete their notes and field plats and for work on the detail maps.

A leveling party under W. S. Williams was retained on the *Patrol* to inspect gauges on the trip up.

Descriptions and elevations of bench marks from Donaldsonville, La., to Head of Passes is appended.

Tables showing slope of river between successive stone lines, discrepancies between the lines of ordinary levels, discrepancies between the ordinary levels and precise levels, and elevations of high-water marks are also appended.

In the reach below Donaldsonville the slope of the river is affected by the tides and the table of surface slopes therefore sometimes shows the downstream station to be the highest.

The following summary gives in detail the amount and character of the field work done:

Working days employed	138
Working days lost by rain	10
Miles of river surveyed	175
Square miles of topography	432
Square miles of hydrography	89
Miles of shore line, lakes, outlets, and canals	192
Lines of soundings	1,184
Casts of lead	22,992
Sextant angles to locate soundings	28,579
Transit angles to locate soundings	10,299
Pages topographical notes	6,208
Pages level notes	830
Pages hydrographical notes	1,603
Pages topographical notes per square mile	14.3
Pages level notes per square mile	1.95
Points located per square mile of topography	288
Average number of soundings per river crossing	20
Average number of soundings located per river crossing	16
Average distance between lines of soundings (meters)	240

For further information pertaining to this work see report of Assistant Engineer A. T. Morrow, Appendix 1 D.

DESCRIPTIONS AND ELEVATIONS OF STONE-LINE BENCH MARKS FROM DONALDSONVILLE, LA., TO HEAD OF PASSES.

NOTE.—These bench marks were set and located geodetically in winter of 1892-'93, and their geographical positions are published in report of 1893, pp. 3608-3619. The elevations were determined from the adjacent precise bench marks in winter of 1893-'94. The elevations are referred to the Memphis datum, which is 8.13 feet below the provisional mean gulf level at Biloxi, Miss., and 13.13 feet above the Cairo datum.

The stone-line bench marks consist of a vitrified tile 18 by 18 by 4 inches. A copper bolt is leaded vertically in the center of this tile, the upper end projecting slightly above face of tile. On the surface of the tile surrounding the bolt is the inscription Mississippi River Commission.

U. S.
B. | | M.
1893.

The tile is buried in the ground from 18 to 40 inches deep, the depth varying with the nature of the material.

On top of the tile a 4-inch wrought-iron gas pipe 4 feet long is set concentric with the copper bolt. The lower end of the pipe is expanded and fits in a circular groove molded in the tile. A cast-iron cap fits over the top of the pipe and is fastened thereto with bronze bolts. The top of the cap bears a similar inscription to that on the tile.

The elevation of copper bolt in tile and top of cap are both determined with the level and are given in the following descriptions. Elevations are given in feet.

Stone line No. 188.—One and one-half miles below Donaldsonville, La., Ascension Parish.

$1\frac{s}{2}$ Tile and pipe on the north side of east and west road through Hermitage plantation; 260 meters above lower side of plantation; about 300 meters northeast of chimney of Hermitage sugarhouse. The prolongation of road strikes a little south of the cold-storage building in Donaldsonville.

△ Lower base, $1\frac{s}{2}$ and $1\frac{s}{2}$ arc in the same straight line. (Moved back on same line 2 feet April 9, 1894.)

$1\frac{s}{2}$ Tile and pipe along fence back of road back of levee at Lower Hermitage plantation landing; almost in front of sugarhouse situated on upper side of road leading directly back from landing. Bench mark is 500 meters above road from sugarhouse to landing, a little above and back of pump house on bank of river. Elevation: Cap on pipe, 30.489; bolt in tile, 26.508 feet.

Stone line 189.—One-fourth mile above landing on Cofield plantation, Point Houmas, La., Ascension Parish.

$1\frac{s}{1}$ Tile and pipe, on west side of canal; which is boundary line between Donaldson and Riverton plantations; pipe is between road and canal and halfway between where road crosses canal and the bend it makes toward Riverton sugarhouse. Elevation: Cap on pipe, 26.428; bolt in tile, 22.436.

$1\frac{s}{2}$ Tile and pipe back of whitewashed board fence back of road, back of levee, on Riverton plantation. It is about 60 meters above canal, which is line between Donaldson and Riverton plantations; also 120 meters above Government light, left bank. (Moved 37.35 meters toward B. M. $1\frac{s}{1}$ in April, 1894.) Elevation: Cap on pipe, 29.532; bolt in tile, 25.538.

$1\frac{s}{2}$ Tile and pipe on Cofield plantation at northwest corner of J. C. Cofield's garden; at intersection of fence along road back of levee, and fence running along upper edge of garden lot. Cofield's residence is 100 meters southeast of bench mark. It is 10 meters from levee and 40 meters from river bank. There is a small hedge inside of fence along road above bench mark. Elevation: Cap on pipe, 31.913; bolt in tile, 27.953.

$1\frac{s}{2}$ Tile and pipe on Cofield plantation on southeast side of intersection of roads. Main road leads to negro quarters, sugarhouse, and river; prolongation of same road leads to water mill at edge of timber; road east runs down through plantation to Leinamis plantation; road southwest runs up through plantation. Pipe is 110 meters south from first cabin of row along east side of road. Elevation: Cap on pipe, 28.093; bolt in tile, 24.130.

Stone line 190.—One-fourth mile below landing on Bagatelle plantation, one-half mile above Union post-office, St. James Parish, La.

$1\frac{s}{1}$ Tile and pipe on St. Mary plantation, 28 meters below line between Bagatelle and St. Mary plantations, on line of Louisville, New Orleans and Texas Railroad. It is 17½ rail lengths below milepost "58 miles to N. O. and 397 miles to Memphis." About 800 meters below Miles Station and on the upper side of first ditch below boundary line. An 18-inch sycamore tree 30 meters N. 60° W. is blazed with a △. Elevation: Cap on pipe, 22.300; bolt in tile, 18.322.

$1\frac{s}{2}$ Tile and pipe on St. Mary plantation inside of fence back of road, back of levee. It is 23 meters below boundary line between St. Mary and Bagatelle plantations. Elevation: Cap on pipe, 29.772; bolt in tile, 25.818.

$1\frac{s}{3}$ Tile and pipe moved from old position in April, 1894, and reset on line between old position and B. M. $1\frac{s}{4}$ 55.92 meters nearer $1\frac{s}{2}$; back of wire fence, 9 meters above northeast corner of old house partially out in road; on property of B. Melangon, 55 meters above St. James store owned by Felix Melangon. Elevation: Cap on pipe, 30.063; bolt in tile, 26.093.

$1\frac{s}{4}$ Tile and pipe on old St. James plantation on land owned by Frasimon and Bertant; on east side of road and between ditch and road; 1 meter from bank of ditch and 1 meter south of culvert over ditch to road running southeast through plantation. By going up stream about 340 meters from B. M. $1\frac{s}{3}$ the road turns to left, through gate, leading directly to B. M. $1\frac{s}{4}$. Elevation: Cap on pipe, 26.898; bolt in tile, 22.943.

Stone line 191.—Three-fourths of a mile above warehouse on Rapidan plantation. St. James Parish, La.

$1\frac{s}{1}$ Tile and pipe on Alta Vela plantation, on Louisville, New Orleans and Texas Railroad right of way, between main track and siding; 57¼ rail lengths below Whitehall Station; 20 rail lengths above lower end of switch at an old road crossing. Elevation: Cap on pipe, 28.122; bolt in tile, 24.160.

$1\frac{s}{2}$ Tile and pipe back of road; back of levee in fence corner on land owned by Alfred Frederick, which is a strip of about one-fourth acre, in front of Alta Vela plantation. Stone is in fence corner between two pairs of bars. A house occupied by Adam Sylvest (colored) is east 20 meters. Elevation: Cap on pipe, 29.475; bolt in tile, 25.520.

$1^{\frac{3}{3}1}$ Tile and pipe in front of St. Louis plantation, on land belonging to Charles Fircuit. It is 3 meters inside of fence along road behind levee; 1 meter from ditch running at right angles to fence, and between this ditch and road running back through plantation. It is 95 meters from river bank, 10 meters from levee, 32 meters above residence of Charles Fircuit, and 39 meters below his store. Distance as chained $1^{\frac{3}{3}1}$ to $1^{\frac{3}{4}1}$ is 990.855 meters. Elevation: Cap on pipe, 24.917; bolt in tile, 20.952.

$1^{\frac{3}{4}1}$ Tile and pipe on St. Louis plantation, on line of road leading back from river and crossroad through plantation. Stone is set at southeast corner between road and ditch, 1 meter west of ditch and 3 meters south of crossroad; 82 meters east of ditch which forms the upper boundary line between St. Louis and St. Alice plantations. Land belongs to Charles Fircuit. Road is prolongation of same road passing $1^{\frac{3}{3}1}$. Bench mark is 393 meters south of cross fence over road. Elevation: Cap on pipe, 21.624; bolt in tile, 17.649.

Stone line 192.—On Celestine plantation, one-fourth mile above Lily store and landing, St. James Parish, La.

$1^{\frac{3}{4}2}$ Tile and pipe on Celestine plantation, property of Felician Ory. It is 48 meters back of Louisville, New Orleans and Texas Railroad, 14½ rail lengths below mile post, "52 miles to N. O.;" on upper bank of second ditch above road leading from river to sugarhouse. Elevation: Cap on pipe, 22.302; bolt in tile, 18.350.

$1^{\frac{3}{3}2}$ Tile and pipe in front of Celestine plantation, back of road back of levee on line of wire and board fence running back from road. Bench mark is 3 meters from corner of fence, 30 meters below house occupied by Felician Ory, 100 meters below Providence store, W. Malarcher, proprietor; at angle of levee about 150 meters above Baton Rouge store. Elevation: Cap on pipe, 28.812; bolt in tile, 24.847.

$1^{\frac{3}{2}2}$ Tile and pipe on St. Prisca plantation, just inside of fence along road behind levee, 10 meters from levee, 110 meters from river bank, 80 meters below St. Prisca store, 30 meters above Climax store, on land of Eugene Dicuit; also 18 meters below road running back to St. Prisca sugarhouse, and 30 meters above blacksmith shop between road and levee. Elevation: Cap on pipe, 29.545; bolt in tile, 25.570.

$1^{\frac{1}{2}2}$ Tile and pipe on St. Prisca plantation, on land of Eugene Dicuit; on south side of ditch leading back from river; 1 meter from ditch at end of crossroad, or turning road leading up to ditch; 153 meters northwest of road running from sugarhouse to river just above Climax store. Elevation: Cap on pipe, 25.868; bolt in tile, 21.883.

Stone line 193.—One-fourth mile above St. Michael's Church at Convent, La., St. James Parish.

$1^{\frac{3}{1}2}$ Tile and pipe on property of Dr. Dellattes, on line of wire fence above St. Michael's Church. Fence is between pasture and abandoned field covered with weeds; 375 meters back of back end of cemetery fence, back of St. Michael's Church. A honey locust tree west 25 meters is blazed with a △. Elevation: Cap on pipe, 20.733; bolt in tile, 16.763.

$1^{\frac{3}{2}2}$ Tile and pipe moved in March, 1894, and reset on line between old position and $1^{\frac{3}{1}2}$, 260.9 meters nearer $1^{\frac{3}{1}2}$; on a small levee in edge of rice field, opposite the mouth of a small ditch, about 10 meters below an old barn. Azimuth to St. Michael's Church spire 18° 09′ 30″. Elevation: Cap on pipe, 25.725; bolt in tile, 21.755.

$1^{\frac{3}{3}2}$ Tile and pipe on Hymel plantation (old St. James estate), inside of fence along road behind levee, and on lower side of road leading back from river to Forestall Station on Texas and Pacific Railroad. Stone is set 10 meters from levee, 4 meters from fence just below it, 108 meters from river bank, 75 meters below S. Hymell's residence. Scattering trees are around house, and a row on each side of road running back to railroad station; former residence of E. G. Forstall. Elevation: Cap on pipe, 26.650; bolt in tile, 22.685.

$1^{\frac{3}{2}2}$ Tile and pipe on Hymel plantation (old St. James estate), on upper side of road leading back from the river to Forestall Station on the Texas and Pacific Railroad, past abandoned sugarhouse of Hymell Bros., formally Forestall plantation. Stone is 40 meters east of first cabin on south side of road, and 74 meters east of first cabin on north side of road. Elevation: Cap on pipe, 24.460; bolt in tile, 20.495.

Stone line 194.—Three-fourths mile below College Landing, at College Point, St. James Parish, La.

$1^{\frac{3}{1}4}$ ⏦ College; screw pile 744.3 meters back of B. M. $1^{\frac{3}{2}4}$, 20 meters east of west boundary line of college property; 15 meters back of a short cross fence, in low, wet ground covered with cottonwood timber. The north side of cap is broken off, but geodetic point remains intact. Elevation of cross cut on cap of screw pile, 23.336.

$1^{\frac{3}{2}4}$ Tile and pipe back of road, back of levee on property of Noel Mather (Col.), 10 meters below line of fence between Mather and Adolph Feuran (Col.), 58 meters southwest of Mather's house, 66 meters southwest of new Sunrise store, 40 meters south of Adolph Feuran's house, one-half mile below 60-mile post to New Orleans. Elevation: Cap on pipe, 28.436; bolt in tile, 24.474.

$1\frac{3}{4}^{A}$ Tile and pipe on line between Home and Pikes Peak plantations, inside of fence along road behind levee, and 2 meters above fence running back, and forming a small inclosure for house and garden. Home plantation is owned by F. Chappin; Pikes Peak plantation by S. and E. Roman. Stone is 10 meters from levee, 9 meters from small ditch running back, and 40 meters from house in inclosure. Elevation: Cap on pipe, 25.465; bolt in tile, 21.485.

$1\frac{4}{4}^{A}$ Tile and pipe set on line between Home and Pikes Peak plantation; 8 meters north of Texas and Pacific Railroad; 2 meters from edge of ditch; 55 meters or $5\frac{1}{2}$ rail lengths below culvert No. 902 A; 9 telegraph poles below Pikes Peak Railroad flag station. Distance chained $1\frac{3}{4}^{A}$ to $1\frac{4}{4}^{A}$ is 775.7 meters. Elevation: Cap on pipe, 21.972; bolt in tile, 18.002.

Stone line 195.—One-fourth mile above Hester Landing, on Hester plantation, Louisiana, St. James Parish.

$1\frac{1}{4}^{A}$ Tile and pipe set on Belle Alliance plantation, owned by J. C. Ross, of New Orleans. Stone is on high embankment, back of canal running east and west on line between church back of quarters and Belmont sugarhouse; 288 meters above first road above Ross residence, running back from river; on same canal that telephone line is on. Distance between $1\frac{1}{4}^{A}$ and $1\frac{2}{4}^{A}$ is 975.3 meters. Elevation: Cap on pipe, 19.833; bolt in tile, 15.868.

$1\frac{2}{4}^{A}$ Tile and pipe moved in March, 1894. New position is one-half meter back of fence which runs back of road inside of new levee. It stands 16 meters above fourth ditch, above residence grounds of plantation, and is 340 meters above plantation sugarhouse; on Hester (Belle Alliance) plantation. Elevation: Cap on pipe, 23.055; bolt in tile, 19.090.

$1\frac{3}{4}^{A}$ Tile and pipe in line between Murry and Home plantations. Home plantation is now called St. Joseph. Stone is on a line between ditch and fence, 10 meters back of fence, back of road back of old levee, 291.5 meters north of stone pillar set on same line; 80 meters below St. Joseph store, on west side of road leading back to Murry sugarhouse; 20 meters back of old levee, about 140 meters back of new levee. Distance $1\frac{3}{4}^{A}$ to $1\frac{4}{4}^{A}$ is 537.41; Elevation: Cap of pipe 28.323, bolt in tile, 24.350.

$1\frac{4}{4}^{A}$ Tile and pipe on line between Murry and Home (now called St. Joseph) plantations. Stone is on edge of ditch on line at intersection of crossroad from Home plantation, 107 meters south of octagon stone pillar set on line between plantations; 57 meters west of road leading from river to Murry sugarhouse; 190 meters south of cabin on east side of line ditch two stone pillars stand on line between $1\frac{3}{4}^{A}$ and $1\frac{4}{4}^{A}$. Elevation: Cap on pipe, 29.710; bolt in tile, 25.745.

Stone line 196.—At landing on Bellvue plantation one-fourth mile below warehouse just below Bourgeois plantation.

$1\frac{2}{4}^{A}$ Tile and pipe on Bellevue plantation, 7 meters back of Louisville, New Orleans and Texas Railroad; 25 rail lengths below mile post, " 44 miles to N. O."; 10 rail lengths above road crossing and also culvert No. 787; on upper side of third ditch above road. Elevation: Cap on pipe, 22.100; bolt in tile, 18.125.

$1\frac{3}{4}^{A}$ Tile and pipe set just in front of fence back of house occupied by Felix Gousain, 100 meters back of old levee on property of Bellvue plantation. Elevation: Cap on pipe, 27.132; bolt in tile, 23.160.

$1\frac{3}{4}^{B}$ Tile and pipe on Magnolia plantation, inside of fence along road leading back from river; 85 meters from road behind levee; 110 meters from river bank; 12 meters above small frame church, known as First Baptist Church (colored). Stone is in inclosure to Louis Gabb's residence; 80 meters from residence a row of large pecan trees run back from river both above and below house. Elevation: Cap on pipe, 26.698; bolt in tile, 22.743.

$1\frac{2}{4}^{B}$ Tile and pipe on old Magnolia plantation, on lower side of road, and between ditch and road leading back from the river; about half way between last two cabins on lower side of road; 56 meters north of crossroad; a row of cabins stand along lower side of road between bench mark and river; distance chained $1\frac{3}{4}^{B}$ to $1\frac{2}{4}^{B}$ 857.5 meters. Elevation: Cap on pipe, 21.310; bolt in tile, 17.335.

Stone line 197.—One mile below Lutcher Landing, St. James Parish.

$1\frac{1}{4}^{Z}$ Tile and pipe on Golden Grove plantation, 417 meters back of Louisville, New Orleans and Texas Railroad; back of and on embankment of canal, which runs directly from Thompson sugarhouse, which is 700 meters above; 157 meters directly west from junction of road from Golden Grove sugarhouse and road running northwest; 60 meters above road running northwest. Elevation: Cap on pipe, 18.769; bolt in tile, 14.794.

$1\frac{2}{4}^{Z}$ Tile and pipe back of fence, back of road back of levee on Golden Grove plantation; 80 meters below square-topped two-story house occupied by A. Waugnespack; about 300 meters above store at Golden Grove plantation; about 220 meters below Old Church. Elevation: Cap on pipe, 26.259; bolt in tile, 22.282.

$1\frac{3}{4}^{Z}$ Tile and pipe set in St. Johns Parish about 1 mile below St. James Parish. Bench mark is inside of fence along road behind levee, 10 meters from levee, 47 meters from river bank, among cluster of small houses; several parties owning narrow

strips of land extending back from river to swamp. Tile is about 450 meters above line of Golden Grove residence, L.-B. 9 meters below fence running back from river, 25 meters above house in inclosure. Elevation: Cap on pipe, 28.377; bolt in tile, 24.407.

$1\frac{1}{4}^{I}$ Tile and pipe on lower side of ditch that runs back from river, 1 meter from ditch and 1 meter north of peach tree; 59 meters southwest of 3-foot pecan tree, alongside of first ditch below; 475 meters south of the fence between B. M. $1\frac{1}{3}^{I}$ and $1\frac{2}{4}^{I}$; bench mark is in Creole settlement, land being divided up into small strips; names of owners can not be had. Distance chained, $1\frac{1}{3}^{I}$ to $1\frac{2}{4}^{I}$, 675.7 meters. Elevation: Cap on pipe, 24.800; bolt in tile, 20.830.

Stone line 198.—1¼ miles above warehouse at Hope Plantation Landing, St. John the Baptist Parish, La.

$1\frac{1}{2}^{b}$ Tile and pipe on Hope plantation, at intersection of plantation roads, 450 meters west of Hope sugarhouse. Pipe is Ⓐ bench mark. Elevation: Cap on pipe, 20.215; bolt in tile, 16.242.

$1\frac{2}{3}^{a}$ Tile and pipe back of fence back of road back of levee on Hope plantation; 250 meters above where Government levee joins old levee; about 850 meters below square-roofed 2-story house (white); about 600 meters above clump of live-oak trees on bank of river. Elevation: Cap on pipe, 21.790; bolt in tile, 17.825.

$1\frac{3}{4}^{a}$ Tile and pipe on old Whitney plantation, inside of fence along road behind old levee, on upper edge of ditch leading back from road, 20 meters from old levee; 346 meters from river bank; 100 meters above Eugene Fancheux's residence; 70 meters below lower cabin between levees. Elevation: Cap on pipe, 27.500; bolt in tile, 23.535.

$1\frac{3}{4}^{a}$ Tile and pipe on old Whitney plantation, on lower edge of road leading back from ruins of Whitney sugarhouse and between road and ditch; 7 meters north of cross ditch; 250 meters south of cross road leading down the river; 270 meters from corner of sugarhouse ruins; 150 meters south of small cross ditch leading to pond back of ruins. Road on which bench mark is set makes a turn at sugarhouse and runs out to river through quarters. Elevation: Cap on pipe, 21.483; bolt in tile, 17.508.

Stone line 199.—Just above warehouse at Union Plantation Landing, St. John the Baptist Parish, La.

$1\frac{1}{2}^{a}$ Tile and pipe 6 meters in front of Louisville, New Orleans and Texas Railroad beside road; 30¼ rail lengths below mile post "36 mi. to N. O.;" on property of Valsin Oubree (colored), 10 meters above line of canal between Oubree's and Union plantations; 10 meters below road running back from B. M. $1\frac{2}{3}^{a}$ across railroad. Elevation: Cap on pipe, 22.544; bolt in tile, 18.572.

$1\frac{2}{3}^{a}$ Tile and pipe in lane back of road back of levee, property of Valsin Oubree. Square-topped house above is occupied by Altores Montz; square-topped house below is occupied by Valsin Oubree; 40 meters below Four Seasons store, owned by Geauguard. Distance $1\frac{1}{1}^{a}$ to $1\frac{2}{2}^{a}$ is 1,109.7 meters. Elevation: Cap on pipe, 25.797; bolt in tile, 21.840.

$1\frac{3}{3}^{a}$ Tile and pipe on land of C. Schexayder, in corner of fence along road behind levee; 10 meters from new levee, 58 meters from old levee, 70 meters from river bank; 70 meters above residence of C. Schexayder, 34 meters above ditch and large siphon pipe over levee. Stone line is opposite the Four Seasons store, left bank; 75 meters below small cross levee between levees. Elevation: Cap on pipe, 24.644; bolt in tile, 20.644.

$1\frac{4}{4}^{a}$ Tile and pipe on land of Pierre Berthalot, on lower edge of third ditch below line ditch between Schexnaydre and Berthalot. One meter east of ditch and 2 meters north of cross road; prolongation of same cross road west would nearly strike old sugarhouse chimney of Schexnaydre, about 600 meters distant. Bench mark is 110 meters east of road leading to river, 116 meters southwest of pecan tree, 18 inches in diameter, with a △ cut on side toward pipe. Distance chained between B. M. $1\frac{3}{3}^{a}$ and $1\frac{4}{4}^{a}$ is 855.1 meters. Elevation: Cap on pipe, 16.736; bolt in tile, 12.771.

Stone line 200.—Three-fourths mile below St. Peter's Church, at St. Peters, La., St. John the Baptist Parish.

$2\frac{1}{1}^{a}$ Tile and pipe on land owned by Nicaisse Madere, 7 meters north of live-oak tree, 30 inches in diameter. Live oak is between two ditches. Bench mark is on upper bank of upper ditch and 100 meters north of east and west fence between pasture and rice field. Elevation: Cap on pipe, 21.420; bolt in tile, 17.470.

$2\frac{2}{2}^{a}$ Tile and pipe back of road back of fence back of levee on the Adams Kellar property. House just below bench mark is occupied by Mr. Gerrett; upper house by Vampren Adonis Duhe; 60 meters below Cornland store. Elevation: Cap on pipe, 24.810; bolt in tile, 20.845.

$2\frac{2}{2}^{a}$ Tile and pipe on Becknel plantation one-half mile below St. John Church, inside of fence along road behind levee and between road and ditch which leads back to Becknel sugarhouse, 25 meters below fence corner, 70 meters from overseer's house.

10 meters from levee, 60 meters from river bank. Distance $^{2}\frac{3}{0}$ to $^{2}\frac{0}{0}$, 1,025.2 meters. Elevation: Cap on pipe, 26.040; bolt in tile, 22.070.

$^{2}\frac{0}{0}$ Tile and pipe on Becknel plantation at intersection of roads, one leading back from river past sugarhouse and the other running up and down through plantation. Bench mark stands between road and ditch, 300 meters south of sugarhouse, at first crossroad. Elevation: Cap on pipe, 20.085; bolt in tile, 16.125.

Stone line 201.—One-fourth mile above depot at La Place, La., St. John the Baptist Parish.

$^{2}\frac{0}{1}$ Tile and pipe on Montague plantation, on river side of road almost in front of Montague's house, 75 meters above junction of roads, also Montague's store. Elevation: Cap on pipe, 25.267; bolt in tile, 21.299.

$^{2}\frac{1}{1}$ Tile and pipe in fence corner, back of levee on line between Montague's plantation and one above; 60 meters above house, about 300 meters above La Place Landing. Elevation: Cap on pipe, 24.144; bolt in tile, 20.196.

$^{2}\frac{0}{1}$ Tile and pipe about one-half mile above Bonnet Carre Point, in yard of Gustave Andry 17 meters below his house, in line with fence running back from river, 23 meters south of road fence behind old levee; 40 meters south of old levee and 110 meters south of new levee; 20 meters southeast of 2-foot pecan tree growing in yard. Elevation: Cap on pipe, 22.855; bolt in tile, 18.890.

$^{2}\frac{1}{1}$ Tile and pipe at side of road leading to Ideal sugarhouse, and between road and ditch, 2 meters west of 36-inch pecan tree branching into three parts about 6 feet above ground; △ cut on side facing pipe; 25 meters south of intersection of ditch with slough. Elevation: Cap on pipe, 21.510; bolt in tile, 17.540.

Stone line 202.—One-fourth mile above abrupt bend in river at Gypsy Point, on Gypsy plantation, St. Charles Parish, La.

$^{2}\frac{0}{2}$ Tile and pipe on Gypsy plantation, about three-fourths mile below crevasse of 1892; on river side of road, 3 meters below hackberry tree 3 feet in diameter, blazed with a △. Bench mark is about 300 meters from levee. Elevation: Cap on pipe, 22.661; bolt in tile, 18.678.

$^{2}\frac{1}{2}$ Tile and pipe along fence back of road back of levee, about three-fourths mile below Bonnet Carre Crevasse of 1892; 30 meters above first house in second clearing below crevasse. House is back 35 meters from road in field, 75 meters above angle in levee. Elevation: Cap on pipe, 23.686; bolt in tile, 18.731.

$^{2}\frac{2}{2}$ Tile and pipe on Hymel plantation at foot of back slope of levee, 150 meters above cottonwood tree 30 inches in diameter, blazed with a △. Tree is 3 meters from base of inner slope of levee; in front of levee in gap between two patches of willows. Elevation: Cap on pipe, 24.876; bolt in tile, 20.901.

$^{2}\frac{0}{2}$ Tile and pipe on top of old levee, 15 meters east of line between St. Johns and St. Charles parishes; 25 meters in front of road on James Hymel plantation. Elevation: Cap on pipe, 29.256; bolt in tile, 25.296.

Stone line 203.—Half mile below landing on New Home plantation, St. Charles Parish, La.

$^{2}\frac{1}{2}$ Tile and pipe on Delamier plantation on road running back to willows; 350 meters above line between Delamier and Hermitage plantations; elm tree 14 inches in diameter is west 7 meters, blazed with a △. Elevation: Cap on pipe, 20.327; bolt in tile, 16.340.

$^{2}\frac{2}{2}$ Tile and pipe back of fence back of road back of levee on Delamier plantation, 350 meters above church, on line between Delamier and Hermitage plantations; 30 meters above house occupied by William Smith (colored); near old sugarhouse ruins. Elevation: Cap on pipe, 24.400; bolt in tile, 20.435.

$^{2}\frac{3}{2}$ Tile and pipe on Davenport plantation, just south of intersection of crossroad east and west with road leading south back into plantation; between road and ditch, 65 meters east of fence around Brou residence; 180 south of line of new levee (projected). Elevation: Cap on pipe, 21.122; bolt in tile, 17.177.

$^{2}\frac{0}{3}$ Tile and pipe on old Davenport plantation, on prolongation of same road as $^{2}\frac{3}{3}$, just south of crossroad between road and ditch on down-river edge of road; about 500 meters north of Texas and Pacific Railroad; plantation owned by A. and V. Brou; distance chained between $^{2}\frac{3}{2}$ and $^{2}\frac{0}{3}$, 840.1 meters. Elevation: Cap on pipe, 16.674; bolt in tile, 12.679.

Stone line 204.—One-fourth mile below Government light on Good Hope plantation, on line between Good Hope and Prospect plantations, St. Charles Parish, La.

$^{2}\frac{0}{4}$ Tile and pipe on Louisville, New Orleans and Texas Railroad; right of way, on line of front row of telegraph poles, 32 rail lengths below Sarpy Station; 4½ rail lengths below lower switch stand, 6 meters in front of track; between the fifth and sixth ditch below the lower section house; at fifth telegraph pole below telegraph station. Elevation: Cap on pipe, 13.220; bolt in tile, 9.265.

$^{2}\frac{1}{4}$ Tile and pipe back of fence, back of road back of levee; at junction of road along levee with road running back to Sarpy Station, on Louisville, New Orleans and Texas Railroad. Bench mark is on Prospect plantation 289 meters below Gov-

ernment light on levee; 80 meters above angle in levee at Ferry Landing; about 700 meters above line out to Prospect sugarhouse. Wild cherry tree is north 19 meters. Elevation: Cap on pipe, 21.550; bolt in tile, 17.582.

$^{29}_{4}$ Tile and pipe in line of fence along road, behind levee, in small orange grove belonging to Plande Bandonin, near his upper line, 11 meters below fence running back between ditches, 27 meters behind levee, 62 meters from river bank. Distance $^{29}_{4}$ to $^{29}_{4}$ 750.04 meters. Elevation: Cap on pipe, 24.542; bolt in tile, 20.569.

$^{29}_{4}$ Tile and pipe on prolongation of same ditch leading back from road, 11 meters above B. M. $^{29}_{4}$ bench mark stands between road and ditch and near intersection of crossroad. It is 460 meters south of fence back of orange grove, on land of Plande Bandonin. Elevation: Cap on pipe, 21.412; bolt in tile, 17.437.

Stone line 205.—Three-fourths mile above Red Church, Louisiana, St. Charles Parish.

$^{29}_{5}$ Tile and pipe on Ormand plantation, on third road, running parallel with river, 60 meters below crossing that runs back from Ormand sugarhouse. Located as follows: At live oak orient on Ormand sugarhouse, turn off 49° 50′ left, to bench mark, 177 meters; at milepost 19—track—turn off 100° left, 493 meters; at Ormand sugarhouse chimney to Prospect sugarhouse cupola turn off 69° 29′ right, 680 meters. Elevation: Cap on pipe, 15.832; bolt in tile, 11.852.

$^{29}_{5}$ Tile and pipe on Ormand plantation, on road running between Ormand residence and negro quarters, 49 meters back of old levee, 25 meters back of line of new levee. Elevation: Cap on pipe, 22.982; bolt in tile, 19.015.

$^{29}_{5}$. Tile and pipe on Esperanza plantation, between ditch and crossroad which is first road back of main road behind levee. This crossroad leads to Esperanza sugarhouse; 320 meters from river bank, 290 meters from road behind levee, about 400 meters above Esperanza sugarhouse, and 261 meters east from railroad; 160 meters behind projected line of new levee. Distance chained between bench marks $^{29}_{5}$ $^{29}_{5}$ is 826 meters. Elevation: Cap on pipe, 20.592; bolt in tile, 16.637.

$^{29}_{5}$ Tile and pipe on line between Fashion and Esperanza plantations, on embankment between two ditches forming line between above plantations; on river side of intersection of ditches with second crossroad back of railroad about 400 meters above road leading to Esperanza sugarhouse. Elevation: Cap on pipe, 17.521; bolt in tile, 13.551.

Stone line 206.—One-fourth mile above old incline of Texas and Pacific Railroad, on Pecan Grove plantation, Louisiana, St. Charles Parish.

$^{29}_{6}$ Tile and pipe on Pecan Grove plantation, on right of way of Louisville, New Orleans and Texas Railroad, 7 meters in front of track, 125 rail lengths below milepost 17, 48 rail lengths below upper switch to siding. Elevation: Cap on pipe, 18.082; bolt in tile, 14.117.

$^{29}_{6}$ Tile and pipe back of road, back of fence, back of levee, on Pecan Grove plantation; 200 meters above upper end of incline used during high water of 1892; 225 meters above Pecan Grove sugarhouse; on lower side of ditch running back to railroad. Elevation: Cap on pipe, 21.342; bolt in tile, 17.362.

$^{29}_{6}$ Tile and pipe on first road above quarters leading back from river and at its intersection with first crossroad behind levee; all on Lone Star plantation, 131 meters south of new levee, 240 meters north of Texas and Pacific Railroad, 216 meters from bank of river. Distance between bench marks $^{29}_{6}$ and $^{29}_{6}$ 856.2 meters. Elevation: Cap on pipe, 19.118; bolt in tile, 15.150.

$^{29}_{6}$ Tile and pipe on Lone Star plantation, on prolongation of road leading back from river by B. M. $^{29}_{6}$. Bench mark is on upper side of road, between road and ditch, 10 meters north of cross ditch, about 500 meters northeast of old Lone Star sugarhouse; 608 meters south of Texas and Pacific Railroad and about half way between Texas and Pacific Railroad and Morgan's Louisiana and Texas Railroad. Elevation: Cap on pipe, 15.335; bolt in tile, 11.390.

Stone line 207.—One-fourth mile below landing on Patterson plantation, St. Charles Parish, La.

$^{29}_{7}$ Tile and pipe on Patterson plantation on right of way of Louisville, New Orleans and Texas Railroad, 15 rail lengths above a road crossing, on upper side of third ditch above road; 17 rail lengths below milepost "14;" 10 rail lengths below levee on line between plantations of Patterson and Rose; 400 meters west of old Almadia sugarhouse. Elevation: Cap on pipe, 14.899; bolt in tile, 10.924.

$^{29}_{7}$ Tile and pipe back of fence back of road back of levee, on Patterson plantation, owned by Hymel, Champagne & Torregrosse, on road leading back to old Almadia sugarhouse. Elevation: Cap on pipe, 20.774; bolt in title, 16.802.

$^{29}_{7}$ Tile and pipe on upper line of Alice plantation, at intersection of ditch running back from road, and small ditch leading west, on property of Arthur Zeringue, 132 meters from levee, 60 meters from stakes of projected new levee, 192 meters from river bank. Elevation: Cap on pipe, 21.432; bolt in tile, 17.457.

$^{29}_{7}$ Tile and pipe on line between Alice plantation and land owned by Arthur Zeringue, about 60 meters south of second crossroad. Line between plantations

consists of small embankment between two ditches with trees here and there the whole length. Distance chained between bench marks $2\frac{9}{7}$ and $2\frac{9}{7}$ 762.65 meters. Elevation: Cap on pipe, 14.479; bolt in tile, 10.514.

Stone line 208.—One-fourth mile above landing at Kenner, La., Jefferson Parish.

$2\frac{9}{8}$ Tile and pipe in lane leading to swamp, one-half meter east of west fence of lane, 2 meters south of an east and west ditch which crosses lane, about 150 meters south of line of timber. Lane is the one 27 meters west of B. M. $2\frac{9}{8}$ and runs north and south. Elevation: Cap on pipe, 11.905; bolt in tile, 7.937.

$2\frac{9}{8}$ Tile and pipe back of fence, back of road, back of levee, in upper part of Kennerville, 27 meters below first street in upper part of town. House occupied by E. Stahl (white) is on opposite corner. Bench mark is just below a prominent bend in levee, 50 meters above house occupied by Walter Davis (colored). Elevation: Cap on pipe, 20.545; bolt in tile, 16.607.

$2\frac{9}{8}$ Tile and pipe on Dusseau plantation along road, behind levee; 198 meters from fence running back from road, along road to quarters and sugarhouse; 50 meters west of large iron pipe over levee, 8 meters back of levee, 70 meters from river bank opposite upper end of Kenner. Elevation: Cap on pipe, 21.461; bolt in tile, 17.496.

$2\frac{9}{8}$ Tile and pipe set on southwest corner of intersection of ditches. Bench mark stands between ditch and road leading to main plantation road, running north to sugarhouse and quarters; about 250 meters west of main road and about 400 meters west of sugarhouse. Elevation: Cap on pipe, 17.360; bolt in tile, 13.375.

Stone line 209.—One mile above landing on Soniat plantation, Soniat Point, Jefferson Parish, La.

$2\frac{9}{9}$ △ Boisblanc. Screw pile on line between the plantations of Mr. Theo. Soniat and B. Boisblanc, 1,060 meters back of levee. A blazed pecan tree is 34 feet northeast from the △, and on farther side of Soniat ditch. The screw pile is 1 foot 8 inches on Boisblanc side of line fence. The top of the letter P on cap of screw pile is the bench. Elevation: 17.200.

$2\frac{9}{9}$ Tile and pipe back of fence, back of road, back of levee, on Boisblanc plantation, at prominent bend of levee, 200 meters above unpainted $1\frac{1}{2}$-story house, with row of magnolias in front. Elevation: Cap on pipe, 19.862; bolt in tile, 15.902.

$2\frac{9}{9}$ Tile and pipe one-half meter north of north line of Willow Wood plantation, on property of John Thompson, in a lane running back from levee, 13 meters back of inside base of levee, and just inside of wire fence along levee road. A cabin stands 20 meters west northwest; about 120 meters from river bank. Elevation: Cap on pipe, 20.810; bolt in tile, 16.860.

$2\frac{9}{9}$ Tile and pipe on line between property of John Thompson and Willow Wood plantation; at intersection of first crossroad north of railroad and road leading back from river, which is the fourth crossroad from river. Bench mark stands on upper edge of road and south of crossroad, on boundary line which is marked by iron posts; about 250 meters north of railroad. Prolongation of road leading to river passes B. M. $2\frac{9}{9}$. Elevation: Cap on pipe, 10.912; bolt in tile, 6.947.

Stone line 210.—One-fourth mile above new incline Illinois Central Railroad below Soniat Point, Jefferson Parish, La.

$2\frac{10}{1}$ Tile and pipe on property of Agricultural Department of Southern University, at fence between cultivated field in front and pasture land behind, on upper side of first ditch below upper line of property. Elevation: Cap on pipe, 18.287; bolt in tile, 14.327.

$2\frac{10}{1}$ Tile and pipe back of fence, back of road, back of levee, on property of Southern University; 20 meters below line between Southern University property and property above; in orange grove a little below sign on bank of river reading "Picayune Saw Mill Lumber Ldg." Elevation: Cap on pipe, 23.387; bolt in tile, 19.415.

$2\frac{10}{1}$ Tile and pipe on Fairfield plantation, about one-half mile above sugar mill, back of fence, back of road, back of levee, between fence and road inside of field, 13 meters from inside base of levee, $3\frac{1}{2}$ meters below line of ditch running back through field; 110 meters below an angle in the levee, and about 125 meters back of river bank. Elevation: Cap on pipe, 15.091; bolt in tile, 11.128.

$2\frac{10}{1}$ Tile and pipe on Fairfield plantation, at intersection of ditch leading back from river with large ditch leading diagonally through plantation, between road and ditch on river side of road. This is main road running diagonally through plantation from drain pump back of railroads to sugar house. Elevation: Cap on pipe, 13.002; bolt in tile, 9.072.

Stone line 211.—Just below Southport elevator, Carrollton, Jefferson Parish, La.

$2\frac{11}{1}$ Tile and pipe on line of fence running back from Steamship Exchange saloon; 50 meters above Illinois Central Railroad tracks to Southport elevator; pasture on upper side, lower side cultivated. Elevation: Cap on pipe, 12.053; bolt in tile, 8.103.

$2\frac{11}{1}$ Tile and pipe, back of fence, back of road, back of levee, 100 meters below Southport elevator; 35 meters above Steamship Exchange saloon, between fence and single track to elevator. Elevation: Cap on pipe, 15.493; bolt in tile, 11.525.

2⅓¹ Tile and pipe on top of old levee at 9-mile point, directly opposite Southport elevator., In front of bench mark is orange-tree nursery. Back of and above is house of Mr. Quinent. Elevation: Cap on pipe, 21.933; bolt in tile, 17.975.

2⅔¹ Tile and pipe on property of Aid Quinent, on line of osage fence between properties of Quinent and Nelson. On "9-mile point" 18-inch pecan tree is east 21 meters, blazed with △. Bench mark is 10 meters northwest of hay barn. Elevation: Cap on pipe, 20.049; bolt in tile, 16.059.

Stone line 212.—Two hundred meters above horticultural building in Audubon Park, New Orleans, Orleans Parish, La.

2½² Ⓐ City Park. Screw pile 1 foot above ground, on grounds formerly City Park, now experimental farm; on cultivated ground, 30 meters south of center of Magazine street, 21 meters south of fence along side of said street, 164 meters above Magazine-street entrance to park grounds, and 264 meters above northwest corner of old Agricultural Hall. Elevation of letter P on cap, 16.931.

2½² Tile and pipe in front of land formerly City Park, now used as experimental farm. Just outside of fence along road behind levee, 120 meters above river entrance to park and where levee branches off from loop around old levee, 20 meters back of levee, about 250 meters from river bank, about 300 meters below exposition wharf. Elevation: Cap on pipe, 20.914; bolt in tile, 16.951.

2⅓² Tile and pipe about 400 meters below Company Canal, at intersection of ditch leading back from levee and road ditch behind levee, 10 meters behind levee, 220 meters below angle in levee, where new levee was joined on to old; about 175 meters from river bank. At angle in levee is "Henry Clay avenue skiff ferry." Elevation: Cap on pipe, 14.422; bolt in tile, 10.477.

2⅔² Tile and pipe on upper edge of ditch leading back from railroad into swamp. Bench mark stands 8 meters from upper edge of ditch, about 150 meters back of Morgan's Louisiana and Texas Railroad, and about 300 meters below Company Canal. Elevation: Cap on pipe, 15.019; bolt in tile, 11.059.

Stone line 213.—At foot of Delachaise street, one-fourth mile above large elevator in New Orleans, Orleans Parish, La.

2½³ Top of fire plug, which is an iron pipe or post 2 feet high, standing one-half meter from gutter on northeast side of Louisiana avenue, 11 meters back of Coliseum street. Elevation: 16.198.

2⅔³ The center of letter "A" in the word "St. Andrew" found in the following impression made in cement pavement on west corner of Delachaise and Magazine streets:

(Chas. Streeck,
473 St. Andrew. Elevation: 15.678.
Cement pavement.)

2⅓³ Tile and pipe back of Morgan's Louisiana and Texas Railroad and 26 meters above Harvey canal; in pasture lot, 744 meters back of levee and river bank. The Louisiana avenue ferry landing is at river end of Harvey canal. Elevation: Cap on pipe, 13.755; bolt in tile, 9.821.

2⅔³ Tile and pipe 26 meters above Harvey canal, in pasture lot, 787.2 meters back of B. M. 2⅓³. Elevation: Cap on pipe, 12.322; bolt in tile, 8.372.

Stone line 214.—Foot of Girod street, New Orleans, Orleans Parish, La.

2¼⁴ Top of Coast Survey Astronomical Post, marked by copper bolt near center of stone in Lafayette Park, New Orleans. It is a little northeast of center of park, and is a limestone slab about 3 feet high and 1 by 3 feet on top. On side is lettered the latitude and longitude of the point. Copper bolt is also permanent bench mark. Elevation: 20.356.

2½⁴ A cup-shaped center to the top of an iron post which stands at lower end of freight house of Louisiana and Northwest Railroad. The post is wrought iron and hollow, with cap. It stands at outer end of low wall running between side track and cart track which enters freight house from northeast; about 100 meters from river bank. Elevation: 25.733.

2⅓⁴ Tile and pipe placed on northwest corner of Lapeyrouse and Chestnut streets; 1 meter north of main ditch leading back and emptying into Verretts Canal; about 400 meters back of levee and 450 meters from river bank. Elevation: Cap on pipe, 12.993; bolt in tile, 9.050.

2¾⁴ Ⓐ Algiers. Screw pile in common back of Algiers; 200 meters south of Firemen's Cemetery, 60 meters back of road, which is a continuation of Webster avenue, 60 meters back of the side track of the Morgan's Louisiana and Texas Railroad, which is farthest from the river. The bench mark is a cross cut in the cap below the letters G. P. Elevation: 10.383.

Stone line 215.—One-fourth mile below Ursuline Convent, New Orleans, Orleans Parish, La.

2½⁵ Tile and pipe on northeast corner of Forstall and Villers street, back of New Orleans and Southern Railroad, and at southwest corner of Mr. Boman's land; just outside of fence corner and between fence and ditch; 346.2 meters back of railway. Elevation: Cap on pipe, 12.134; bolt in tile, 8.192.

$2\frac{1}{2}^{5}$ Tile and pipe on upper side of Forstall street, back of levee; just back of small cross street leading up the river, connecting with Forstall street just opposite "Commercial Soap Works;" 684 meters in front of New Orleans and Southern Railroad, 92 meters from river bank, and about 600 meters below Ursuline Convent; 81 meters to base of levee. Elevation: Cap on pipe, 17.929; bolt in tile, 13.972.

$2\frac{1}{3}^{5}$ Tile and pipe on land of J. A. Webert, No. 1005 Patterson street, Algiers. Bench mark is on lower edge of lane leading back from levee; 33 meters back of stable, 284 meters back of levee and river bank; 8 meters back of cross ditch leading down stream. Elevation: Cap on pipe, 17.078; bolt in tile, 13.110.

$2\frac{1}{3}^{5}$ Tile and pipe on prolongation of same road and ditch and 717.25 meters back of B. M. $2\frac{1}{3}^{4}$. Elevation: Cap on pipe, 13.593; bolt in tile, 9.628.

Stone line 216.—One mile below Chalmette monument, in New Orleans, St. Bernard Parish, La.

$2\frac{1}{4}^{6}$ Tile and pipe on line between land of Jules Brou and Mrs. Alberdine, on lower side of fence, 158.5 meters back of New Orleans and Southern Railroad, about 200 meters above point opposite old sugar refinery. Elevation: Cap on pipe, 14.675; bolt in tile, 10.695.

$2\frac{1}{2}^{6}$ Tile and pipe on boundary line between land of Jules Brou and Mrs. Alberdine, just below line fence and just back of lane and double row of evergreen trees, about 200 meters above old sugar refinery, 290 meters back of levee, 310 meters from river bank, 750 meters in front of railroad. Bench mark stands in corner of fence, 57.5 meters back of northwest corner of house occupied by Louis Heils. Elevation: Cap on pipe, 18.425; bolt in tile, 14.475.

$2\frac{1}{3}^{6}$ Tile and pipe on small ridge on upper side of Cut-Off road, being nearly on line (lower) of Aurora plantation. On lower side of road is village of Cut-Off. Bench mark is 85.6 meters back of levee and river bank, about 200 meters above old sugar refinery on left bank. Elevation: Cap on pipe, 17.680; bolt in tile, 13.733.

$2\frac{1}{4}^{6}$ Tile and pipe on top of levee running back from river and up stream, forming back levee for Aurora plantation. Bench mark is 10 meters in front of turn of levee just across Cut-Off road from large ditch leading down river. Elevation: Cap on pipe, 15.215; bolt in tile, 11.250.

Stone line 217.—One-half mile above Saxonholm depot on New Orleans and Southern Railroad, St. Bernard Parish, La.

$2\frac{1}{2}^{7}$ Ⓓ Ducross. A screw pile found in rice field 6 meters south of upper line of Ducross plantation, near back of plantation, stands 1 foot above ground; a 16-inch live oak 22 meters distant, bearing 225° (magnetic) blazed with a △ facing secondary. Elevation of smooth surface of cap below the letters G. P., 10.082.

$2\frac{1}{4}^{7}$ Tile and pipe on lower edge of first ditch below upper line of Ducross plantation, 4 rail lengths below upper line. Bench mark stands 1 meter below ditch; 10 meters back of New Orleans and Southern Railroad; about 100 meters above dwelling house and quarters; 31 meters back of levee; 100 meters from river bank; line ditch now known as line between Walker and Ducross plantations. Is directly back of junction of old and new levees. (Pipe taken out in 1894, it being in center of road.) Elevation: Bolt in tile, 12.330.

$2\frac{1}{3}^{7}$ Tile and pipe on Stanton plantation on upper edge of first road leading back from levee, below dwelling and quarters. Bench mark stands between road and ditch and just back of crossroad leading up through plantation and passing into yard in front of dwelling; about 140 meters below dwelling, 234 meters back of levee, 265 meters from river bank. Property owned by Milliken & Rutledge. Elevation: Cap on pipe, 18.445; bolt in tile, 14.475.

$2\frac{1}{4}^{7}$ Tile and pipe on prolongation of same road as described for B. M. $2\frac{1}{3}^{7}$ on lower edge and in front of ditch which runs in front of back crossroad. Elevation: Cap on pipe, 14.270; bolt in tile, 10.308.

Stone line 218.—One mile below Lake Borgne Canal, St. Bernard Parish, La.

$2\frac{1}{3}^{8}$ Tile and pipe on prolongation of ditch leading back from levee, just below quarters and old sugarhouse ruins, on Old Repose plantation. Bench mark is 1 meter above ditch, 3 meters north of center of ditch, 9.45 meters east of 10-inch willow blazed with △. Elevation: Cap on pipe, 12.246; bolt in tile, 8.292.

$2\frac{1}{2}^{8}$ Tile and pipe on Old Repose plantation, sometimes called Merritts, now occupied by Italians, and planted in vegetables. Bench mark is on upper side of ditch leading back from levee to swamp, 3 meters above ditch, 10 meters back of center of railroad track, in corner of fence, 197 meters back of base of levee, 239.48 meters back of river bank. Ditch leads back just below quarters and old sugarhouse ruins; about 650 meters below Lake Borgne Canal; land owned by Italian named Dotree. Elevation: Cap on pipe, 14.344; bolt in tile, 10.383.

$2\frac{1}{3}^{8}$ Tile and pipe on upper line of Beka or 12-mile point plantation, on ridge 1 meter below ditch, 31 meters in front of crossroad leading from upper line down toward dwelling, 123 meters back of levee, 150 meters from river bank. Elevation: Cap on pipe, 19.161; bolt in tile, 15.196.

$2\frac{1}{4}^{8}$ Tile and pipe on 12-mile Point plantation at intersection of ditches, 1 meter above sixth ditch below upper plantation line and 1 meter east of large ditch; also,

1 meter above sixth ditch above road leading to sugarhouse, 110 meters above large ditch running east and west; 255 meters below upper line of plantation. Elevation: Cap on pipe, 16.728; bolt in tile, 12.778.

Stone line 219.—One and one-half miles below parish line, between St. Bernard and Plaquemines parishes, La.

$2\frac{1}{4}^{9}$ Tile and pipe on Orange Grove plantation, 440 meters back of railroad, on east side of road running back through plantation, and crossing railroad at upper end of switch. Bench mark is at northeast corner of intersection of ditches, about 120 meters back of corner of fence separating field from swamp, 12 meters east of fence. Elevation: Cap on pipe, 12.311; bolt in tile, 8.366.

$2\frac{1}{2}^{9}$ Tile and pipe on Orange Grove plantation, about 900 meters above sugarhouse, at northeast corner of intersection of ditches, 160 meters above crossroad and railway switch and elevated platform for loading cane into cars; 130 meters back of new levee, 180 meters from river bank, 267 meters in front of railroad track. Elevation: Cap on pipe, 14.916; bolt in tile, 10.968.

$2\frac{3}{4}^{9}$ Tile and pipe on old Magnolia plantation, known as Upper Magnolia, property of Charles Lantern. Bench mark is on ridge leading up from quarters and on lower edge of the fourth ditch above quarters, being 160 meters above same; about 150 meters above point where old and new levees join; 50 meters back of old levee, 60 meters back of new levee, 90 meters from river bank, 40 meters back of Cherokee hedge, back of main road. Elevation: Cap on pipe, 17.727; bolt in tile, 13.782.

$2\frac{1}{4}^{9}$ △ Magnolia. Found as described in U. S. Coast Survey Report. Point was preserved, earthen pyramid removed and replaced with a △ pipe and tile; on upper line of Magnolia plantation at intersection of ditches, southeast corner; a willow branching into four parts that grows at intersection of ditches is blazed with a △; land of Charles A. Lantern. Embankment between ditches is reported as line between Plaquemines and Orleans parishes. Elevation: Cap on pipe, 14.022; bolt in tile, 10.065.

Stone line 220.—One-fourth mile above warehouse at St. Clair Landing, Plaquemines Parish, La.

$2\frac{1}{4}^{0}$ Tile and pipe on St. Clair plantation, at intersection of road running back through plantation and large ditch with levee back of it running parallel with river at northwest corner of intersection, 362 meters back of railroad; land owned by George Garr. Elevation: Cap on pipe, 15,476; bolt in tile, 11,516.

$2\frac{1}{2}^{0}$ Tile and pipe on St. Clair plantation, 1 meter back of fence back of road, 32 meters back of levee, 430 meters in front of railroad, in line with plantation road described above; 390 meters above St. Clair sugarhouse; land of George Garr; chained distance between $2\frac{1}{4}^{0}$ and $2\frac{1}{2}^{0}$ 792.27 meters. Elevation: Cap on pipe, 17,821; bolt in tile, 13.860.

$2\frac{3}{4}^{0}$ Tile and pipe on Belle Chasse plantation, on upper edge of ditch leading back from main road back of levee to swamp; 15 meters back of base of levee, 75 meters from river bank, about 150 meters below where levee runs out around old crevasse; about 400 meters above St. Clair sugarhouse on opposite bank; about 1,800 meters above Belle Chasse sugarhouse. Elevation: Cap on pipe, 15.026; bolt in tile, 11.061.

$2\frac{1}{4}^{0}$ Tile and pipe on prolongation of ditch passing near B. M. $2\frac{3}{4}^{0}$ and on back ridge of up-and-down ditch. Bench mark is 43 meters in front of large ditch or canal, just in front of back levee at edge of swamp. Elevation: Cap on pipe, 13.234; bolt in tile, 9.281.

Stone line 221—One mile above Stella Landing. One mile below Scarsdale Landing, Plaquemines Parish, La.

$2\frac{1}{4}^{1}$ Tile and pipe on upper edge of prolongation of ditch passing B. M. $2\frac{1}{2}^{1}$; at intersection of up-and-down ditch, being first ditch and crossroad back of back levee; 47 meters above line between Stella and Scarsdale plantations; 297.5 meters back of levee; 594.8 meters back of railroad near front edge of swamp. Elevation: Cap on pipe, 13.556; bolt in tile, 9.609.

$2\frac{1}{2}^{1}$ Tile and pipe on Scarsdale plantation, on upper edge of second ditch above Stella plantation, at intersection with ditch running parallel with river, and in front of second road back of levee; about 172 meters from river bank, 47 meters above plantation line, 152.8 meters in front of railroad. Elevation: Cap on pipe, 15.876; bolt in tile, 11.917.

$2\frac{3}{4}^{1}$ Tile and pipe on Concession plantion, 3 meters back of railroad and 6½ rail lengths above switch leading to sugarhouse. Bench mark is in small patch of vacant ground between rail and wagon roads; 48 meters back of levee, 77 meters from river bank, about 250 meters above Concession sugarhouse, 1 meter below first telegraph pole above switch; property owned by George Anderson. Elevation: Cap on pipe, 17.509; bolt in tile, 13.553.

$2\frac{1}{4}^{1}$ Tile and pipe on middle levee, which runs through center of plantation, acting as a protection in case either front or back levees break. Bench mark is in middle of levee about midway between first and second roads above the road leading to sugarhouse. Elevation: Cap on pipe, 16.646; bolt in tile, 12.678.

Stone line 222.—At Linwood plantation landing, Plaquemines Parish, La.

$2\frac{12}{12}$ Tile and pipe on north side of same road as B. M. $2\frac{12}{12}$ between ditch and road, 1 meter from ditch and 4 meters from center of road; 19 meters east of ditch running north and 15 meters west of ditch running south. Elevation: Cap on pipe, 12.081; bolt in tile, 8.136.

$2\frac{11}{12}$ Tile and pipe on north side of Linwood plantation road, owned by E. L. Lothrop, between road and ditch, 1 meter from ditch, 4 meters from center of road, 12 meters back of center of railroad track. Elevation: Cap on pipe, 14.194; bolt in in tile, 10.237.

$2\frac{10}{12}$ Tile and pipe on upper line of Cedar Grove plantation, between road and ditch leading back to swamp. Bench mark is 19 meters back of levee, 50 meters from river bank, 60 meters from Mrs. J. F. Shuppert's dwelling house, 370 meters in front of railroad. Elevation: Cap on pipe, 18.077; bolt in tile, 14.132.

$2\frac{9}{12}$ Tile and pipe between road and ditch described above, 8 meters back of large ditch leading downstream; 55 meters below switch on Augusta plantation; 190 meters back of railroad; 385 meters above △ Cedar. Elevation: Cap on pipe, 12.952; bolt in tile, 9.002.

Stone line 223—One half mile below Government light at Bertrandville Settlement, Plaquemines Parish, La.

$2\frac{8}{12}$ Tile and pipe on old Woodland plantation, now divided up into small tracts and occupied by Italians. Bench mark is back of ditch running up and down in front of timber 14 meters above ditch leading back from main road, 237 meters back of railroad. Elevation: Cap on pipe, 13.855; bolt in tile, 9.880.

$2\frac{7}{12}$ △ Berthoud. Screw pile in old Woodland plantation, 10 meters in front of old levee, 8 meters above ditch, 232 meters in front of railroad, 101 meters back of new levee, 150 meters from river bank; on property of Charles Resseau. Elevation: Cross on cap of screw pile, 16.295.

$2\frac{6}{12}$ Tile and pipe on land of Widow DeDoberd, about 350 meters below Jesuit Church, on upper edge of large ditch leading back from road to swamp; 70 meters back of levee, 110 meters back of river bank, 151 meters in front of railroad, and 53 meters from Widow DeDoberd's house. Elevation: Cap on pipe, 15.929; bolt in tile, 11.986.

$2\frac{5}{12}$ Tile and pipe on upper edge of same ditch as B. M. $2\frac{5}{12}$, about 200 meters from edge of willows; 559 meters back of railroad. Elevation: Cap on pipe, 13.018; bolt in tile, 9.056.

Stone line 224. One-fourth mile below Belair plantation landing, Plaquemines Parish, La.

$2\frac{4}{12}$ Tile and pipe on Belair plantation, on north side of road running back from railroad, about 400 meters south of depot, between road and ditch, and 3 meters from cross ditch running along side of road, 411.6 meters back of center of railroad track. Elevation: Cap on pipe, 13.989; bolt in tile, 10.034.

$2\frac{3}{12}$ Tile and pipe on Alliance plantation, just inside corner of fence which runs along road behind new levee and turns back just below colored church, which stands in southwest corner of negro quarters. Bench mark is 12.5 meters from base of levee, 17 meters from southwest corner of said church. Elevation: Cap on pipe, 13.491; bolt in tile, 9.533.

$2\frac{2}{12}$ Tile and pipe on Star plantation, between road and ditch, both leading back from main road back of levee; 6 meters back of main road ditch, 15 meters back of levee, 90 meters from river bank, 361 meters in front of railroad. Property owned by Mr. Molen. Elevation: Cap on pipe, 16.336; bolt in tile, 12.378.

$2\frac{1}{12}$ Tile and pipe on same ditch; running back from main road to swamp, upper edge of ditch, and just back of ditch running upstream and turning back into swamp; 319 meters back of railroad, 60 meters in front of swamp. Elevation: Cap on pipe, 12.488; bolt in tile, 8.531.

Stone line 225.—One-fourth mile below Espy Landing and Espy Station, New Orleans and Southern Railroad, Plaquemines Parish, La.

$2\frac{12}{12}$ Tile and pipe on lower side of Monticello plantation road 487 meters back of center of railroad, 2 meters in front of north and south ditch. About 100 meters north stands a small frame house. Road runs back to pump house. Elevation: Cap on pipe, 11.525; bolt in tile, 7.550.

$2\frac{11}{12}$ Tile and pipe on lower side of Monticello plantation road, at its intersection with road running back of levee, 15 meters from levee, 208.3 meters in front of center of railroad, at northwest corner of yard around plantation residence, and about 60 meters from residence. Elevation: Cap on pipe, 15.263; bolt in tile, 11.281.

$2\frac{10}{12}$ Tile and pipe on Alliance plantation, nearly opposite Monticello store, on L. B., at intersection of ditches, one leading back from levee, with one running northwest and southeast at edge of swamp. Bench mark stands on lower edge of ditch leading back from levee, and 3 meters in front of cross ditch, 237 meters back of railroad, 253 meters from levee, 296 meters from river bank, and about 900 meters from Alliance sugarhouse. Property owned by T. S. Wilkinson. Elevation: Cap on pipe, 12.502; bolt in tile, 8.542.

$^{2\frac{3}{4}A}$ Tile and pipe on Alliance plantation, at edge of field back of willow swamp, on prolongation of same ditch as B. M. $^{2\frac{3}{4}A}$. Bench mark stands on lower edge, 21 meters back of large ditch that turns downstream and then back into swamp. On property of T. S. Wilkinson. Elevation: Cap on pipe, 12.532; bolt in tile, 8.560.

Stone line 226.—One-half mile above St. Sophia post-office, Plaquemines Parish, La.

$^{2\frac{3}{4}B}$ Tile and pipe on lower edge of ditch running back about one-half mile above the two frame churches of St. John and St. Joseph, at negro settlement below Poverty Point. Bench mark is 237.1 meters back of center of railroad. Elevation: Cap on pipe, 11.794; bolt in tile, 7.844.

$^{2\frac{3}{4}C}$ Tile and pipe on inside of fence back of road, back of levee, on lower side of ditch running back through rice fields, 14 meters back of base of levee, on property of C. W. Johnson (colored). Bench mark is 304.5 meters in front of railroad track. Elevation: Cap on pipe, 15.924; bolt in tile, 11.973.

$^{2\frac{3}{4}D}$ Tile and pipe on Myrtle Grove plantation, on upper edge of first ditch above sugarhouse leading back from main road to swamp, 15 meters back of levee, 44 meters above sugarhouse, 279 meters in front of railroad, 72 meters from river bank. Property owned by T. S. Wilkinson. Elevation: Cap on pipe, 14.036; bolt in tile, 10.081.

$^{2\frac{4}{4}D}$ Tile and pipe on prolongation of same ditch as B. M. $^{2\frac{3}{4}D}$, past a large ditch leading downstream. Bench mark is on top of protection levee, 5 meters back of downstream ditch, 185 meters back of railroad. Elevation: Cap on pipe, 10.581; bolt in tile, 6.638.

Stone line 227.—One-fourth mile above Harlem Plantation Landing, Plaquemines Parish, La.

$^{2\frac{1}{4}7}$ Tile and pipe on mound which has once been the foundation for some building, 313.2 meters back of center of railroad and 3 meters south of east and west ditch, 10 meters east of large north and south ditch. Elevation: Cap on pipe, 12.182; bolt in tile, 8.232.

$^{2\frac{3}{4}7}$ Tile and pipe on Harlem plantation, on south side of ditch running back from upper side of large grove of live oaks, about 350 meters above large brick mill in ruins, 65 meters back of levee, 140.8 meters in front of railroad; 30-inch live oak, 270°, 19 meters, and 30-inch live oak, 348°, 22 meters, are blazed with △ s. Elevation: Cap on pipe, 13.955; bolt in tile, 9.981.

$^{2\frac{4}{4}7}$ Tile and pipe in August Fortier's front yard, on lower edge of small ditch, 3 meters back of main-road fence, back of road, 10 meters back of levee, 30 meters from river bank, 4 meters below iron post which is on upper line of land of August Fortier, 45 meters from his house, 130 meters above embankment or protection levee on upper line of Deer Range plantation, 409 meters in front of railroad, 80 meters in front of tomb. Elevation: Cap on pipe, 14.833; bolt in tile, 10.889.

$^{2\frac{1}{4}7}$ Tile and pipe at angle of protection levee leading back from river levee and where it turns off downstream. Bench mark stands on top of embankment, on line between Deer Range plantation and land owned by Wade Walker, 433 meters back of railroad. Elevation: Cap on pipe, 15.730; bolt in tile, 11.775.

Stone line 228.—One mile below Union Plantation Landing, 4 miles above Pointe a La Hache Landing, Plaquemines Parish, La.

$^{2\frac{3}{4}8}$ Tile and pipe on south side of ditch running parallel with river, 9 meters west of main ditch running back through rice field between land of Dr. Herbert and Jack O'Doles, 776 meters back of B. M. $^{2\frac{1}{2}8}$, 392 meters back of timber, 542 meters back of railroad. Elevation: Cap on pipe, 10.914; bolt in tile, 6.954.

$^{2\frac{1}{2}8}$ Tile and pipe in lane at its intersection with main road behind levee, about 100 meters from river. Elevation: Cap on pipe, 14.752; bolt in tile, 10.783.

$^{2\frac{3}{4}8}$ Tile and pipe on upper line of Point Celeste plantation, on levee running back from main road behind levee across railroad, joining levee leading downstream. Bench mark is 15 meters back of river levee, 65 meters from river bank, 120 meters in front of railroad. Elevation: Cap on pipe, 15.581; bolt in tile, 11.638.

$^{2\frac{1}{4}8}$ Tile and pipe on prolongation of same levee as B. M. $^{2\frac{3}{4}8}$, 629 meters back of railroad. Elevation: Cap on pipe, 12.379; bolt in tile, 8.429.

Stone line 229.—One-fourth mile above St. Thomas Church, Pointe a La Hache, Plaquemines Parish, La.

$^{2\frac{3}{4}9}$ Tile and pipe on south side of double ditch running back on line between land of John Lafitte and B. Savois. Bench mark is 619 meters back of center of railroad track. Elevation: Cap on pipe, 11.892; bolt in tile, 7.937.

$^{2\frac{3}{4}B}$ Tile and pipe on line between land of John Lafitte and B. Savois, 13 meters back of levee, 1 meter north of line of large willows in corner of fence, about 400 meters above St. Thomas Church. Elevation: Cap on pipe, 13.985; bolt in tile, 10.030.

$^{2\frac{3}{4}D}$ Tile and pipe on Woodland plantation, 6 meters back of railroad track on upper edge of large ditch leading back from railroad to canal, also at intersection of roads, one leading to sugarhouse, the other running back through plantation, about

1,000 meters below Woodland sugarhouse, and about 800 meters above Diamond plantation and store. Elevation: Cap on pipe, 14.279; bolt in tile, 10.314.

$^{2}\frac{1}{4}^{9}$ Tile and pipe on upper edge of prolongation of same ditch as bench mark $^{2}\frac{1}{3}^{9}$, and at its intersection with very large ditch or canal on Woodland plantation, property of Bradish Johnson. Elevation: Cap on pipe, 9.711; bolt in tile, 5.736.

Stone line 230.—One and one-half miles above Bohemia Plantation Landing, Bohemia Point, Louisiana.

$^{2}\frac{3}{4}^{0}$ Tile and pipe on north side of plantation road running along north side of rice plantation of Martin Bros., 1 meter from north line of plantation, on south edge of ditch on land of Cosse. Bench mark is 538.8 meters back of center of railroad. Elevation: Cap on pipe, 10.624; bolt in tile, 6.660.

$^{2}\frac{3}{2}^{0}$ Tile and pipe on north side of plantation road running along north side of Martin Bros. rice plantation, 1 meter from north line of said plantation. Road is 10 meters wide and bounded by two deep ditches. Bench mark is 22 meters back of levee. Elevation: Cap on pipe, 13.354; bolt in tile, 9.389.

$^{2}\frac{3}{3}^{0}$ Tile and pipe on Magnolia plantation of George Warmouth, on upper side of main plantation road leading back from railroad past sugarhouse, between road and ditch, 3 meters from coal scales, 28 meters above warehouse, 18 meters back of railroad, 10 meters below switch leading back to sugarhouse, 65 meters back of levee, 75 meters from river bank. Elevation: Cap on pipe, 13.903; bolt in tile, 9.966.

$^{2}\frac{3}{4}^{0}$ Tile and pipe on Magnolia plantation, on prolongation of road leading back from railroad and sugarhouse to pump house. Bench mark is set within the turn of large ditch leading into large ditch leading straight back to pump house. Bench mark stands in live-oak grove used as burying ground about 250 meters in front of pump house, 7 meters east of 3-foot live-oak tree blazed with △. Elevation: Cap on pipe, 12.685; bolt in tile, 8.723.

Stone line 231.—One and one-half miles below Bohemia Plantation Landing, Bohemia Point, Louisiana.

$^{2}\frac{3}{1}^{1}$ Tile and pipe on lower edge of prolongation of ditch leading backward from B. M. $^{2}\frac{3}{1}^{1}$, 454 meters back of lane leading back from house of William Gannon. Elevation: Cap on pipe, 11.485; bolt in tile, 7.530.

$^{2}\frac{3}{2}^{1}$ Tile and pipe on line between land of William Gannon and George Wilson; in line of fence between ditches leading back from new levee to old levee and main road, 23 meters back of new levee, 119 meters from river bank, 125 meters from old levee, 165 meters west of George Wilson's house. Elevation: Cap on pipe, 13.450; bolt in tile, 9.496.

$^{2}\frac{3}{3}^{1}$ Tile and pipe on upper edge of large ditch leading back from road behind levee, past railroad through rice field to bayou. Bench mark stands 75 meters back of levee, 100 meters from river, 180 meters in front of railroad, about 1,000 meters below Socola Canal, 115 meters below lower line of Riceland plantation; on land of John Harris; 10 meters below small frame house occupied by Joseph Demoll. Elevation: Cap on pipe, 13.042; bolt in tile, 9.084.

$^{2}\frac{3}{4}^{1}$ Tile and pipe on upper edge of same ditch running back past B. M. $^{2}\frac{3}{3}^{1}$ 283 meters back of New Orleans, Fort Jackson and Grand Island Railroad. Elevation: Cap on pipe, 11.886; bolt in tile, 7.926.

Stone line 232.—One-half mile below upper line of Huling Settlement, Plaquemines Parish, La.

$^{2}\frac{3}{2}^{2}$ Tile and pipe on property of Mrs. Charles Cannon, 118 meters above her house, 1 meter below fence running back from road behind levee, separating a small field from the vegetable garden of E. J. Cannon, 12 meters from the south corner of his house, 55 meters back of levee, 70 meters from river bank. A fig tree stands 4 meters south. Elevation: Cap on pipe, 13.228; bolt in tile, 9.274.

$^{2}\frac{3}{4}^{2}$ Tile and pipe placed 1 meter inside the front fence of A. Rigand's orange grove, 4½ meters from center of railroad track and 3 meters above an orange tree standing at fence, 44 meters from house of A. Rigand, and 26 meters below upper edge of grove. Elevation: Cap on pipe, 14.080; bolt in tile, 10.115.

$^{2}\frac{3}{4}^{2}$ Tile and pipe on southwest edge of a ditch in rice field, property of A. Rigand, 9 meters northwest of main ditch, running back from river. About 100 meters south stands an old windmill; 820 meters back of New Orleans, Fort Jackson and Grand Island Railroad. Elevation: Cap on pipe, 10.474; bolt in tile, 6.532.

Stone line 233.—One and one-fourth miles below Nestor Canal, Plaquemines Parish, La.

$^{2}\frac{3}{4}^{3}$ Tile and pipe on old Burton place, on lower edge of large ditch leading back from road at lower side of garden. Bench mark stands 28 meters north of 2-foot cypress tree, 8 meters east of 10-inch live oak, 12 meters northwest of 12-inch live oak, all blazed with a △. Land occupied by A. H. Decker; owned by Arena J. Barker. Elevation: Cap on pipe, 13.057; bolt in tile, 9.107.

$^{2}\frac{3}{3}^{3}$ Tile and pipe on old Burton place, just inside fence along road, behind levee, and 5 meters below fence leading back. Bench mark stands 28 meters from house

occupied by A. H. Decker, 10 meters back of levee, 106 meters from river bank. Land owned by Arena J. Barker. Elevation: Cap on pipe, 14.360; bolt in tile, 10.410.

$^{23}_{3}$ Tile and pipe on upper edge of line ditch between land of Edward Lassus and Emile Bougon, 2 meters from edge of ditch, 45 meters back of road behind levee, 70 meters from river bank, 400 meters above St. Patrick's Church, and about 250 meters below the old abandoned Lono Canal; 147 meters northeast of railroad; 30 meters, below house of Joseph Quilo. Elevation: Cap on pipe, 13.321; bolt in tile, 9.364.

$^{23}_{4}$ Tile and pipe 432 meters back of railroad on upper edge of ditch leading back from levee, past B. M. $^{23}_{3}$. Elevation: Cap on pipe, 11.388; bolt in tile, 7.430.

Stone line 234.—Just below Daisy post-office and Wesley church, Plaquemines Parish, La.

$^{23}_{4}$ Tile and pipe on land of Berkson Bros., of New Orleans, on upper edge of ditch leading back from road, 12 meters back of road behind levee, directly back of where new levee branches off from old levee; 17 meters below house occupied by William Howard, 140 meters below Methodist Church South, known as Wesley church, 18 meters back of levee and 105 meters from river bank; 60 meters northwest of 3-foot hackberry tree standing 8 meters outside of levee blazed with △. Elevation: Cap on pipe, 13.665; bolt in tile, 9.690.

$^{23}_{4}$ Tile and pipe in orange grove opposite Wesley church, on left bank, at intersection of ditches on land of Bradish Johnson, 228 meters back of levee, 265 meters from bank of river, on line with cabin in grove occupied by Paul Levy, 100 meters below intersection of old and new levees. Elevation: Cap on pipe, 14.370; bolt in tile, 10.417.

$^{23}_{4}$ Tile and pipe on land of A. C. Gilmore, known as Nairn plantation, on line of large ditch, being the second large one back of railroad, 3 meters back of small ditch, being boundary line between Gregory and Gilmore, 110 meters above intersection of ditches. $^{23}_{4}$, $^{23}_{4}$ and △ 180 are in line with Wesley church spire on left bank. Bench mark is 245 meters back of railroad. Elevation: Cap on pipe, 12.420; bolt in tile, 8.478.

Stone line 235.—One-quarter mile below Lower Bayou at Grand Prairie Settlement Plaquemines Parish, La.

$^{23}_{5}$ Tile and pipe on land of Meyer Wise, 15 meters back of road behind levee, 50 meters above the corner of John J. Kelley's fence, and 195 meters above his house; 20 meters back of levee, 70 meters from river bank, 290 meters below Hack Bayou. Elevation: Cap on pipe, 13.245; bolt in tile, 9.275.

$^{23}_{5}$ Tile and pipe on Drosen Augusten Buras's plantation; in small patch of ground lying between levee and railroad; on line of fence, 3 meters east of railroad, 16 meters west of levee, 60 meters from river bank, and 40 meters south of Empire schoolhouse; 6½ rail lengths below Drosen Buras's house. Elevation: Cap on pipe, 13.537; bolt in tile, 9.582.

$^{23}_{5}$ Tile and pipe on D. A. Buras's plantation, in line of fence where willow trees form the posts; 5 meters above large ditch leading back from railroad; 92 meters back from cross ditch and orange grove. Elevation: Cap on pipe, 10.782; bolt in tile, 6.817.

Stone line 236.—One-half mile below O. K. Red Store Landing, Plaquemines Parish, La.

$^{23}_{6}$ Tile and pipe on plantation of Vincent Lococo, on back levee, 280 meters below where it turns at right angles and runs to front levee; 11 meters above ditch and water gate through levee, and 255 meters above where levee turns at right angles and runs to front levee. Elevation: Cap on pipe, 14.676; bolt in tile, 10.711.

$^{23}_{6}$ Tile and pipe on land owned by Vincent Lococo, of New Orleans, on line of fence back of road behind levee, and fence running back around garden; about 450 meters below colored Methodist Episcopal church, 10 meters back of levee, and 50 meters from river bank; 15 meters below magnolia tree, the only one in vicinity; about 750 meters below O. K. Red Store. Elevation: Cap on pipe, 12.876; bolt in tile, 8.921.

$^{23}_{6}$ Tile and pipe on land of Clement Bulot, in southwest corner of yard, corner next to lane, 60 meters back of levee, 80 meters from river bank, 120 meters northeast of railroad, and about 400 meters below Tropical Bend store; 20 meters from southwest corner of dwelling of Clement Bulot, which is a double frame, one story and a half high. Elevation: Cap on pipe, 11.667; bolt in tile, 7.708.

Stone line 237.—One mile above old Quarantine Landing, Plaquemines Parish La.

$^{23}_{7}$ Tile and pipe on land of August Barry, about three-fourths mile above old quarantine station. Bench mark is in corner of fence along levee, and fence leading back, which is the line between Barry and Jones property; 15 meters southeast of Barry's house, 10 meters back of levee, just below ditch, and 140 meters from river bank. Elevation: Cap on pipe, 13.486; bolt in tile, 9.540.

$^{23}_{7}$ Tile and pipe on land owned by Mrs. Pelas, 12 meters back of fence along road behind levee and 10 meters below house occupied by John Pelas; 100 meters north

of railroad, on upper edge of ditch leading back to railroad, 18 meters back of levee and 44 meters from river bank; about 70 meters below prominent bend in levee. Elevation: Cap on pipe, 12.272; bolt in tile, 8.319.

Stone line 238.—At Neptune Landing and post-office, Plaquemines Parish, La.

$2\frac{38}{2}$ Tile and pipe 10 meters back of center of levee, 25 meters from bank of river, 20 meters above Mrs. S. H. Butler's store and Neptune post-office. Bench mark is at end of lane running back from road along levee; about 300 meters above large two-story house on opposite side of river. Elevation: Cap on pipe, 13.627; bolt in tile, 9.675.

$2\frac{38}{2}$ Tile and pipe on back slope of levee, on lower side of road leading back from levee, between land of Frederick Gasket above and Mrs. Laurence Brocher below; at angle in levee, 428 meters above schoolhouse and 563 meters above large two-story house (white); 45 meters in front of house of Frederick Gasket. Elevation: Cap on pipe, 15.030; bolt in tile, 11.066.

Stone line 239.—One-fourth mile below Fort St. Philip Landing, Plaquemines Parish, La.

$2\frac{39}{2}$ Tile and pipe on Fort St. Philip Reservation, 50 meters northwest of lower reservation stone, 109 meters from edge of water of river, 72 meters back from right angle in levee on top of same levee, at angle. Elevation: Cap on pipe, 14.286. bolt in tile, 10.335.

$2\frac{39}{2}$ Tile and pipe on Fort Jackson Reservation, 45 meters back of levee, 28 meters above old quarters just outside of levee on edge of river, 130 meters below prominent angle of levee where old and new levee join. Just inside of angle is an old pump house with engine and boiler. Bench mark is on lower side of graded road, leading back from levee to house occupied by Peter E. B. Ostrom, ordnance-sergeant U. S. Army. House is 25 meters back of bench mark. Elevation: Cap on pipe, 13.573; bolt in tile, 9.613.

Stone line 240.—One mile above New Lucas Canal, Plaquemines Parish, La.

$2\frac{40}{2}$ Tile and pipe in prairie, 80 meters from river bank, about 1,000 meters above a group of houses. Tile is buried about 2 feet and a mound of earth raised around the pipe. No object is near to refer bench mark to. Elevation: Cap on pipe, 12.400; bolt in tile, 8.450.

$2\frac{40}{2}$ Tile and pipe in low ground back of levee, 13.4 meters below wire fence around orange grove of Schoenberger. Tile is 20 inches below surface and mound of earth raised around pipe; ash tree 8 inches diameter, 30°, 10 meters, hackberry 10 inches diameter, 230°, 5 meters, both blazed with △. Elevation: Cap on pipe, 13.062; bolt in tile, 9.131.

Stone line 241.—One and one-half miles above old salt works, Plaquemines Parish, La.

$2\frac{41}{2}$ Tile and pipe 50 meters from river bank on open prairie, 50.5 meters, 120°, (magnetic) from a 15-inch spreading willow, which has △ blazed on side. Bench mark is one-half mile below Lucas Canal. Elevation: Cap on pipe, 12.360; bolt in tile, 8.390.

$2\frac{41}{2}$ Tile and pipe inside of fence behind levee, and just below fence leading back from levee forming inclosure to yard around house. Bench mark is in young orange grove, land of Norbert Buras, 17 meters in front of his house, 10 meters from levee, 45 meters from river bank, about 3 miles above Jump. Elevation: Cap on pipe, 13.040; bolt in tile, 9.075.

Stone line 242—One-half mile below Baptiste Collet's Bayou, Plaquemines Parish, La.

$2\frac{42}{2}$ Tile and pipe 85 meters from edge of water, 13 meters below draw from river, back of and below two houses which are 110 meters from bench mark; 70 meters below fence corner. Front house is occupied by William Gray, back house by Barnum Schofield. Willow 8 inches diameter is south 36 meters, blazed with △. Elevation: Cap on pipe, 12.865; bolt in tile, 8.923.

$2\frac{42}{2}$ Tile and pipe 100 meters above the "Jump," 53 meters above and in front of "Plaquemines Tropical Fruit Company's" store; 81 meters from water's edge, 45 meters below and back of Levy's general merchandise store, on line of footpath between the two stores. Willow 18 inches in diameter is southeast by east 16 meters. Willow 16 inches in diameter is north 13 meters, both blazed with △. Elevation: Cap on pipe, 13.916; bolt in tile, 9.963.

Stone line 243.—Two and three-fourths miles below the Jump, Plaquemines Parish, La.

$2\frac{43}{2}$ Tile and pipe $3\frac{3}{4}$ miles above quarantine, on line of telegraph poles, 39 meters from water's edge, 13 meters east of cluster of willows. The one nearest river is blazed with a △, and "B. M. $2\frac{43}{2}$" put in blazed part with lead pencil. Elevation: Cap on pipe, 12.890; bolt in tile, 8.935.

$2\frac{43}{2}$ Tile and pipe 24 meters from water's edge, 2 meters east of willow 15 inches in diameter, blazed with △, within which is marked (B. M. $2\frac{43}{2}$). Elevation: Cap on pipe, 13.567; bolt in tile, 9.616.

Stone line 244.—Three-fourths mile above Quarantine Station, Plaquemines Parish, La.

$2\frac{1}{4}$ Tile and pipe $17\frac{1}{2}$ telegraph poles above quarantine, 21 meters above Richards Marchinas's grave, 27 meters from water's edge, 5 meters back of telegraph line. Elevation: Cap on pipe, 12.450; bolt in tile, 8.510.

$2\frac{1}{3}$ Tile and pipe 30 meters from edge of water, 125 meters above vacant house on river edge—the first house on river bank above quarantine. Elevation: Cap on pipe, 12.481; bolt in tile, 8.529.

Stone line 245.—At Pilots' Headquarters, parish of Plaquemines, La.

$2\frac{1}{2}$ Tile and pipe 20 meters from edge of water at Pilot Town, about 2 miles above Head of Passes, 15 meters in front and 10 meters below house occupied by pilots, 10 meters below walk to wharf, 40 meters above old house on edge of river, 14 meters west of fence corner. Elevation: Cap on pipe, 11.605, bolt in tile, 7.625.

$2\frac{1}{2}$ Tile and pipe 30 meters from edge of water of river, in willows directly opposite Pilot Town. Willows are cut down around bench mark. A 4-pronged willow stands 215°, distant 14 meters, blazed with △. T. B. M. No. 8 stands 8 meters off at 76°. Elevation: Cap on pipe, 11.132.

TABLE 9.—*Slope of the river between successive stone lines from Donaldsonville to Head of Passes.*

From stone line to stone line.	Slope.	From stone line to stone line.	Slope.
	Feet.		*Feet.*
Donaldsonville gauge to 188	—0.270	214 to 215	—0.138
188 to 189	—0.155	215 to 216	—0.135
189 to 190	—0.620	216 to 217	—0.069
190 to 191	—0.093	217 to 218	—0.100
191 to 192	—0.412	218 to 219	—0.148
192 to 193	—0.097	219 to 220	+0.010
193 to 194	—0.245	220 to 221	—0.112
194 to 195	—0.314	221 to 222	—0.085
195 to 196	—0.280	222 to 223	—0.043
196 to 197	—0.198	223 to 224	+0.030
197 to 198	—0.189	224 to 225	—0.098
198 to 199	—0.207	225 to 226	—0.015
199 to 200	—0.163	226 to 227	—0.050
200 to 201	—0.045	227 to 228	+0.010
201 to 202	—0.353	228 to 229	+0.055
202 to 203	—0.050	229 to 230	—0.045
203 to 204	—0.199	230 to 231	+0.050
204 to 205	—0.155	231 to 232	—0.133
205 to 206	—0.329	232 to 233	—0.155
206 to 207	—0.183	233 to 234	0.000
207 to 208	—0.260	234 to 235	—0.111
208 to 209	—0.170	235 to 236	+0.101
209 to 210	—0.108	236 to 237	+0.078
210 to 211	—0.185	237 to 238	—0.028
211 to 212	+0.035	238 to 239	0.000
212 to 213	—0.188	239 to 240	+0.070
213 to 214	—0.207	240 to 241	—0.070

TABLE 10.—*Discrepancies between right and left bank levels.*

River crossing at—	Distance.	Discrepancy.	River crossing at—	Distance.	Discrepancy.
	Miles.	*Feet.*		*Miles.*	*Feet.*
Stone line 242	12	—0.31	Stone line 214	3	—0.01
241	3	—0.25	213	3	0.05
240	3	+0.07	212	3	0.20
238	6	+0.09	211	3	0.06
237	3	+0.03	210	3	0.17
236	3	+0.13	209	3	0.07
235	3	+0.08	208	3	0.04
234	3	—0.09	207	3	0.10
233	3	—0.03	206	3	0.16
232	3	—0.15	205	3	0.12
231	3	—0.07	204	3	0.00
230	3	—0.01	203	3	0.19
229	3	—0.07	202	3	0.08
228	3	—0.02	201	3	0.14
227	3	+0.12	200	3	0.16
226	3	—0.06	199	3	0.01
225	3	—0.17	198	3	0.16
224	3	+0.11	197	3	0.03
223	3	—0.03	196	3	0.04
222	3	—0.04	195	3	0.04
221	3	—0.09	194	3	0.07
220	3	0.00	193	3	0.02
219	3	—0.04	192	3	0.06
218	3	—0.06	191	3	0.06
217	3	+0.12	190	3	0.14
216	3	+0.07	189	3	0.07
215	3	—0.09	Donaldsonville gauge	4½	0.16

NOTE.—Below New Orleans, or stone line 214, the discrepancies given are between the elevations obtained by river crossings from precise B. M's., and those obtained by the line of ordinary levels on the opposite bank from precise B. M's. Above New Orleans the discrepancies given are between the two lines of ordinary levels on opposite banks, the line being adjusted at each crossing.

TABLE 11.—*Discrepancies between precise and ordinary levels.*

Between P. B. M's.	Distance.	Discrepancy.	Leveled by—
	Miles.	*Feet.*	
1 A and 2½	13	—0.31	W. H. Roper.
2½ and T. B. M. 28	5	—0.25	Do.
T. B. M. 28 and 2¾	5	+0.07	Do.
2¾ and 2¾	3½	—0.10	Do.
T. B. M. 28 and 8 A	2	+0.06	W. H. Roper and W. S. Williams.
T. B. M. 28 and 8	2	+0.07	Do.
T. B. M. 28 and T. B. M. 31	2	+0.07	Do.
8 A and 2¼ A	1½	+0.02	W. S. Williams.
8 A and 2¼	1½	+0.01	Do.
2¼ and T. B. M. 58	1½	0.00	Do.
2½ and 9 A	1½	—0.01	Do.
2¼ and 9	1½	—0.01	Do.
T. B. M. 58 and 10	1½	+0.02	Do.
10 and 2¾ A	½	—0.01	Do.
10 and 2¾	½	—0 02	Do.
10 and B. M. A	½	—0.02	Do.
10 and T. B. M. 61	½	—0.02	Do.
10 and exper. B. M	½	—0.02	Do.
11 and 2¾	1/16	0.00	Do.
11 and 13 A	1½	—0.06	Do.
11 and T. B. M. 65	1½	—0.06	Do.
13 A and 2¾ A	1½	+0.01	Do.
13 A and 2¾	1½	+0.03	Do.
13 A and T. B. M. 68	1½	+0.04	Do.
2¾ A and 14	1	—0.09	W. H. Roper.
2¾ A and 14 A	1	—0.10	Do.
14 A and 15	1	+0.02	Do.
15 and 2¾ A	1	—0.02	Do.
15 and 2¾	1	—0.02	Do.
2¾ A and 16 A	1½	—0.07	W. S. Williams
16 A and 2¾ A	1½	+0.03	Do.
16 A and 2¾	1½	+0.03	Do.
2¾ A and 17 A	1½	—0.05	W. H. Roper.
2¾ A and 17	1½	—0.07	Do.
17 A and 2¾ A	1½	—0.09	Do.
17 A and 2¾	1½	—0.09	Do.
18 and 2¾ A	1½	—0.04	Do.
2¾ A and 18	1½	+0.06	Do.

TABLE 11.—*Discrepancies between precise and ordinary levels*—Continued.

Between P. B. M's.	Distance.	Discrepancy.	Leveled by—
	Miles.	*Feet.*	
23/4 A and △ white	1	0.00	W. H. Roper.
△ white and 19 A	1	0.00	Do.
19 A and 20 A	2½	−0.05	Do.
23/2 A and 20 A	1½	+0.08	Do.
21/2 A and 21 A	1½	−0.03	Do.
23/3 A and 21	1½	−0.03	Do.
21 A and △ Union	¼	0.00	Do.
△ Union and T. B. M. 95	¼	−0.07	Do.
T. B. M. 95 and 23/1 A	1	0.00	Do.
T. B. M. 95 and 23/1	1	0.00	Do.
23/1 A and T. B. M. 97	¾	+0.01	Do.
T. B. M. 97 and 22 A	¾	+0.02	Do.
T. B. M. 97 and 22	¾	+0.03	Do.
22 A and 23/0 A	1⅛	−0.06	Do.
22 A and 23/0	1⅛	−0.06	Do.
23/0 A and 23 A	1	+0.02	Do.
21/2 A and 23	1	0.00	Do.
23 A and 24	1	0.00	Do.
24 and 23/2 A	1	+0.09	Do.
24 and 23/2	1	+0.04	Do.
23/3 A and 25 A	1⅛	−0.03	Do.
23/3 A and 25	1⅛	−0.03	Do.
25 A and 23/3 A	1⅛	−0.05	Do.
23/4 A and 26 A	1⅛	−0.03	Do.
26 A and 23/1 A	1⅛	−0.07	Do.
26 A and 23/1	1⅛	−0.07	Do.
26 A and T. B. M. 114	1⅛	−0.07	Do.
23/1 A and 27 A	1⅛	−0.06	Do.
23/1 A and 27	1⅛	−0.04	Do.
27 A and 23/2 A	1⅛	+0.01	Do.
27 A and 23/2	1⅛	+0.01	Do.
23/2 A and T. B. M. 122	1	−0.04	Do.
T. B. M. 122 and 28 A	⅛	−0.03	Do.
T. B. M. 122 and 28	⅛	−0.04	Do.
28 A and 23/3 A	1⅛	+0.01	Do.
28 A and 23/3	1⅛	+0.02	Do.
23/3 A and 29 A	1⅛	−0.02	Do.
23/3 A and 29	1⅛	−0.02	Do.
29 A and 23/4 A	1⅛	+0.02	Do.
29 A and 23/4	1⅛	+0.02	Do.
23/4 A and T. B. M. 131	1⅛	+0.12	W. S. Williams.
23/4 A and 30 A	1⅛	+0.12	Do.
23/4 A and 30	1⅛	+0.12	Do.
T. B. M. 131 and 23/3	1⅛	0.00	Do.
23/3 and 31 A	1⅛	−0.04	Do.
31 A and T. B. M. 136	1⅛	+0.01	Do.
T. B. M. 136 and 23/2 A	⅛	+0.01	Do.
T. B. M. 136 and 23/2	⅛	0.00	Do.
T. B. M. 136 and T. B. M. 137	¾	+0.02	F. F. Axtell.
T. B. M. 137 and 32 A	¾	−0.03	Do.
32 A and 23/1 A	1⅛	−0.01	Do.
23/1 A and 33 A	1⅛	+0.09	Do.
33 A and 23/2 A	1⅛	−0.03	Do.
23/0 A and 34 A	1⅛	−0.04	Do.
34 A and 23/0 A	1⅛	−0.07	Do.
23/0 A and 35 A	1½	−0.08	J. S. Miller.
35 A and 23/0 A	1⅛	−0.01	Do.
23/0 A and T. B. M. 151	⅛	+0.04	Do.
T. B. M. 151 and 36 A	1	−0.04	Do.
T. B. M. 151 and 36	1	−0.01	Do.
36 A and T. B. M. 154	1⅛	−0.03	Do.
T. B. M. 154 and 23/7	1⅛	−0.02	Do.
23/7 and 37 A	1⅛	−0.03	Do.
23/7 and 37	1⅛	−0.01	Do.
37 A and 23/0	1⅛	−0.03	Do.
23/0 and 38	1⅛	−0.05	Do.
38 and 23/2 A	2	−0.07	Do.
23/2 and 23/4=43	4	−0.18	J. S. Miller and W. S. Williams
43 and city stone $\left\lvert \frac{XX}{M.R.} \right\rvert$	8	+0.02	Do.
$\left\lvert \frac{XX}{M.R.} \right\rvert$ and P. B. M. Carrollton	½	−0.13	W. S. Williams
City stone $\left\lvert \frac{XX}{M.R.} \right\rvert$ and II	6¾	+0.18	W. S. Williams and J. S. Miller.
II and IV	7¾	−0.16	Do.
IV and V	3¾	+0.11	W. S. Williams and W. H. Roper.

TABLE 11.—*Discrepancies between precise and ordinary levels*—Continued.

Between P. B. M's.	Distance.	Discrepancy.	Leveled by—
	Miles.	*Feet.*	
V and VI	4¼	—0.01	W. S. Williams and W. H. Roper.
VI and VII	4¾	—0.12	Do.
VII and X	15½	—0.11	Do.
X and XII	8	—0.12	Do.
XII and XIII	3	—0.06	Do.
XIII and XIV	3	—0.04	Do.
XIV and XV	3½	+0.15	Do.
XV and XVI	5	—0.14	Do.
XVI and XVII	7½	+0.13	Do.

NOTE.—From Head of Passes (P. B. M. 1) to New Orleans (P. B. M. 43) the discrepancies are between precise levels and the single line of ordinary levels on the same bank; above New Orleans, or from P. B. M. 43 to B. M. XVII, the discrepancies are between precise levels and the two lines of ordinary levels combined.

TABLE 12.—*Elevations of high-water marks between Head of Passes and Donaldsonville, La.*

Locality.	Kind of mark.	Year.	Elevation, Memphis datum.	Remarks.
			Feet.	
Buras, La., Pelican store	Top baseboard of counter	1893	14.17	Tidal wave, Oct. 1.
¼ mile above Buras, La	Mark on door of house	1893	14.14	Do.
About 2 miles above $\frac{2}{3}^{12}$ ⊡ 185 F.	Floor of Pat Williams's house	1893	13.57	Do.
¼ mile above $\frac{2}{3}^{13}$, foreman's house on Bradish Johnson's orange farm.	Top third step of house	1893	13.11	High water back of levee after storm, Oct. 1.
Do	Top of levee	1893	16.53	Tidal wave from river, Oct. 1.
Do	Spike in pecan tree	1890	14.72	Established by assistant State engineer.
Do		1893	15.02	
Magnolia plantation, B. M. $\frac{2}{3}^{12}$	8 ft. 6 in. mark on gauge	1893	16.58	
Pointe La Hache, P. B. M. 24	Mark on court-house steps	1893	15.58?	
Noemi store, about 1 mile below $\frac{2}{3}^{14}$.	Spike in tree	1893	18.37	Do.
About ¼ mile above $\frac{2}{3}^{14}$ ⊡ 2 D	do	1893	18.85	
About 1½ miles above $\frac{2}{3}^{12}$ ⊡ 20 D.	Mud stain on fascine	1893	18.84	
About ¼ mile below $\frac{2}{3}^{12}$ ⊡ 444 C	do	1893	18.95	
Oak Point ¼ mile above $\frac{2}{3}^{12}$	Spike in pecan tree	1893	18.94	Considered very reliable.
About 1½ miles above $\frac{2}{3}^{12}$ △ 272	Spike in live-oak tree	1893	17.91?	Back of levee.
Concession store ¼ mile below $\frac{2}{3}^{11}$	Notch in windmill tower	1893	20.17	Wind blowing upstream when notch was cut.
Do	Mud stain on fascine	1893	19.21	
P. B. M. 32, left bank	do	1893	19.14	
Fort St. Leon, 1½ miles above $\frac{2}{3}^{10}$	Mark on wall of fort	1892	29.86	
Do	do	1893	20.61	
House at Fort St. Leon plantation ⊡ 426 A.	Notch cut in willow on batture.	1892	20.56	Information from Arthur Brulard, owner of Fort St. Leon plantation.
Upper line Fort St. Leon plantation ⊡ 430 A.	Top of stake in old levee	1892	20.43	
2 miles above $\frac{2}{3}^{9}$	Boat spike in fascine	1893	21.21	
Do	Mud stain on fascine	1893	21.01	
2 miles above $\frac{2}{3}^{12}$ ⊡ 102 D	do	1893	21.53	
B. M. $\frac{2}{3}^{8}$	Spike in fascine	1893	22.24	Levee engineer's mark.
Do	Mud stain on fascine	1893	21.94	
1 mile above $\frac{2}{3}^{8}$ ⊡ 458 A	Spike in fascine	1893	22.57	Do.
1½ miles above $\frac{2}{3}^{8}$	do	1893	22.67	Do.
Southern Pacific Transfer L. B. New Orleans.	Mark on gauge	1890	22.55	
Southern Pacific Transfer R. B. New Orleans.	do	1890	22.55	
Do	do	1892	23.04	
Do	do	1893	23.28	
Canal-street gauge, New Orleans.	Gauge reading	1862	21.61	
Do	do	1871? 1874	21.81	
Do	do	1884	21.52	
Do	do	1890	22.58	
Do	do	1892	22.81	

TABLE 12.—*Elevation of high-water marks between Head of Passes and Donaldsonville, La.*—Continued.

Locality	Kind of mark.	Year.	Elevation, Memphis datum.	Remarks.
			Feet.	
South Side plantation, 1½ miles above $\frac{2}{3}^{3}$.	Gauge on warehouse	1890	23.81	
Do	do	1891	23.51	
Do	do	1892	24.51	
Do	do	1893	24.71	
Avondale plantation, 1¼ miles above $\frac{2}{1}^{0}$.	Top of stump, front of residence.	1893	26.07	
Do	Mud stain on fascine	1893	25.70	
Oakland plantation, 1 mile above $\frac{2}{2}^{0}$.	Cleat nailed on oak tree	1893	26.49	Date not certain.
Woodland plantation, 1 mile below $\frac{2}{3}^{1}$.	Notch in corner of cooper shop.	1892	29.90	
Do	do	1893	30.46	
¼ mile below $\frac{1}{3}^{6}$	Gauge on pump house	1893	32.66	
Do	Mud stain on pump house	1893	32.36	
¼ mile below $\frac{1}{3}^{7}$	Gauge on live-oak tree	1890	30.65	
Do	do	1891	30.07	Gauge kept by F. J. Waguespack.
Do	do	1892	31.52	
Do	do	1893	32.38	
College Point, near gauge bulletin.	Mud stain on fascine	1893	33.60	
College Point, about 200 meters below $\frac{1}{2}^{8}$.	Gauge on house on batture	1892	33.86	Gauge kept by Mr. Daman.
Do	do	1893	34.28	
About 300 meters above $\frac{1}{2}^{2}$	Mud stain on pump house	1893	34.29	
About 600 meters above $\frac{1}{2}^{1}$	Gauge on thorn tree	1892	34.67	
Do	do	1893	35.15	
Do	Spike in thorn tree	1892	34.79	
Burnside post-office, ¾ mile below $\frac{1}{2}^{9}$.	Spike in live oak	1893	36.41	
B. M. $\frac{1}{2}^{4}$	Mud stain on warehouse	1893	36.59	
Donaldsonville, La	Iron column of drug store	1874	36.28	
Do	do	1884	36.59	
Do	Gauge reading	1893	37.22	

GAUGE INSPECTION.

Advantage was taken of the transfer of the steamer *Patrol* and outfit to the lower river work, to test and put in thorough repair the 17 gauges and bulletins pertaining to the Mississippi River Commission.

The party, with Assistant Engineer J. A. Ockerson in charge, left St. Louis on Saturday, October 7, stopping at the U. S. Engineer Depot en route to store some condemned and unserviceable property.

At each gauge station the gauge was tested and repaired, the gauge bulletins put in order, and the notes of the observer were examined.

Duplicate lines of levels were run from the nearest reliable bench marks, the discrepancies were noted, and the gauges reestablished at the proper elevation if found to be in error.

The locations of the gauges are the same as given in the report of 1893, and the bench marks, with few exceptions (which will be noted), are also the same.

A high-water inspection was also made on the return trip of the *Patrol* from April 12 to May 14. This inspection was made by Mr. W. S. Williams, and the discrepancies, if any, found at each gauge are noted below.

The results are as follows:

Gray's Point, Missouri, October 10.—Permanent gauge fixed to the natural rock. This gauge does not reach down to the low-water mark and should be extended down to zero when stage of river will permit.

The bulletin was found to be in good order and records fair.

B. M. 74 is between the two sections of the gauge, 21 feet downstream from the upstream section of the gauge and 109 feet upstream from the downstream section of the gauge. It reads 15.16 feet on gauge.

Gray's house, referred to in previous descriptions of location, was destroyed by fire on June 26, 1893, and gauge book was lost in the fire.

Belmont, Mo.—A new gauge was nailed over the old one, as the figures were rather dim. It is in two sections, viz, 0 feet to 18 feet at southeast corner and 18 feet to 48 feet at southwest corner of elevator.

The greatest discrepancy found in the gauge was 0.03 feet.

Bulletin was in good order and records fair. It was inspected again May 8, 1894, and found correct.

Considerable doubt existed as to the elevation of the zero of this gauge above the Cairo datum plane, although it is known that the gauge itself has not been changed for several years, if at all. There may have been an error in the first determination of the elevation of the gauge zero when the gauge was transferred from Columbus to Belmont. The records are not as explicit as they should be, and do not show definitely how this was done.

On April 1, 1893, a duplicate line of precise levels was run from P. B. M. 8 in Columbus, Ky., to the gauge and the gauge bench marks at Belmont. There was no evidence of any disturbance of P. B. M. 8. The zero of the gauge was found to be 287.394 feet above Cairo datum.

On October 10 a duplicate line of ordinary levels was run from P. B. M. 8 to the gauge and gauge bench marks, and zero of gauge from these levels was 287.488 feet, differing from the precise-level value less than a tenth of a foot.

On May 7, 1894, a duplicate line of precise levels was run from P. B. M. 10 to P. B. M. 8. P. B. M. 10 is on the bluffs below Columbus, in firm ground, where no disturbance is likely to occur.

Using the value for this P. B. M. given in Annual Report, 1881, p. 52, viz, 472.210 feet, and the elevation by this line of levels gives P. B. M. 8 327.216 feet or 0.589 foot lower than the value given for it when set.

Taking the difference of level between P. B. M. 8 and the gauge at Belmont, as determined in April, 1893, and combining with the line from P. B. M. 10 to P. B. M. 8, and we have elevation of zero of Belmont gauge above Cairo datum = 286.805 feet.

The elevation of zero of gauge from B. M. 3/3, determined several times since 1886, is 286.890 feet.

This close agreement, further verified by a bench between P. B. Ms. 8 and 10, seems to show that P. B. M. 8 has been disturbed since it was first set.

The elevation of the zero of the gauge may therefore be safely taken as the mean of the determinations from P. B. M. 10 and B. M. 3/3, or 286.85 feet.

Morrison, Mo., October 11.—This gauge is in seven sections. The high-water section, reading from 34 to 42.9, is firmly spiked to a large sycamore tree. The other sections are vertical posts set at intervals down a gently sloping bank where they are exposed to the floating drift, and consequently should be classed as temporary. The errors in the different sections ranged from 0, at the permanent section, to 0.8 feet on the fifth section. These corrections were duly applied to the records, and hydrograph platted accordingly.

The position of the gauge when first established was a good one, but later a bar formed in the bend, which left the gauge in a pocket at the lower stages, and a new gauge was established to take its place at mouth of St. John's Bayou, about a mile and a half below Morrison.

Morrison gauge was therefore abandoned and bulletin dismantled on October 11, 1894.

New Madrid, Mo., October 11.—This gauge was established in November, 1892, to take the place of Morrison gauge. The greatest discrepancy found was 0.1 feet. All of the sections of the gauge were found to be in good condition.

The iron bulletin was in good order and the records well kept.

The gauge above 15-foot mark was examined May 2, 1894, and found correct within a tenth of a foot.

Cottonwood Point, Mo., October 12.—With the exception of the high-water section, which is spiked to a large cottonwood tree, all of the sections are vertical posts set at intervals down a sloping bank. Some of these sections had been disturbed by drift. They were straightened up and reset. The greatest discrepancy found was 0.1 foot.

The iron bulletin was in good order and the records exceptionally well kept.

An examination of the sections above the 16-foot mark was made May 2, 1894.

The observer was reading on a temporary section placed near his house, some 3,000 feet above the site of the gauge proper. The readings on the gauge near the observer's house are 0.1 foot too high. This temporary gauge was used from April 29.

Fulton, Tenn., October 13.—This is a very difficult gauge to maintain, owing to the ice and drift which sweeps close along the shore. All but one section was destroyed and afterwards replaced by the gauge observer. The error in these sections was found to be 0.1 foot. The gauge sections were reset as firmly as practicable. The bulletin is in good order and the records well kept.

This gauge above the 16-foot mark was examined on May 2, 1894. Section reading 18 to 24 feet was found 0.085 foot too high and was reset at proper elevation.

Section reading 12 to 19 feet was found to be 0.072 foot too low, but could not be reset on account of the water.

Wittsburg, Ark., St. Francis River, October 14.—From 15 up to 50 feet the gauge is in one section spiked to a large pecan tree and is practically permanent. The section from 15 down to 4 feet is also spiked to a tree.

This section was found to be 0.47 foot too low. Below 4 feet the stage is read on a temporary stake. This stake was found to be 0.54 foot too low.

This gauge was discontinued October 14, owing to the difficulty of getting a good observer and also because it is difficult of access. It is replaced by a gauge at the bridge of the St. Louis, Iron Mountain and Southern Railway, some 14 miles by river above Wittsburg.

St. Louis, Iron Mountain and Southern Railway bridge, St. Francis River, October 14.—This gauge is on the railroad bridge across the St. Francis River. From 6 to 46 feet the gauge is in one section, bolted to the struts between the cylindrical iron piers. Top of lower brace reads on gauge 9.05 feet; top of second brace, 20.90 feet; top of third brace, 32.97 feet; top of fourth brace, 46.06 feet; top of upstream cylindrical pier, 47.11 feet; base of rail, 53 feet. Each and all of these marks answer as bench marks for this gauge.

Below the 6-foot mark the stage is read from a temporary stake established by the observer. This stake was found to be 0.64 foot too low.

The absence of the observer at time of inspection prevented an examination of the records. The stage reported by observer on date of inspection was 1.36 feet lower than that read by inspector. Later investigation disclosed the fact that the observer had more than one temporary gauge, but no definite information could be obtained by means of which the reported stages below 6 feet could be corrected. There is no bulletin at this point.

Mhoon Landing, Miss., October 16.—All but two sections of this gauge were demolished by drift and ice. The observer attempted to replace the sections with temporary stakes as the water receded below the 20-foot mark. At zero his readings were found to be 1.52 feet too large, and at 15 feet 1.82 feet too large.

The disturbed sections were replaced at the proper elevation. The bulletin was moved to a position near the gauge.

This gauge is quite a distance from the nearest inhabitant, and it is probable that it is frequently neglected, as shown by the discrepancies usually found in the temporary gauges.

The sections above the 10-foot mark were examined on April 30, 1894. Section 19 to 24 feet, on which observer had been reading since February 28, was found to be 0.10 too high.

Section 24 to 30.5 feet was leaning and has been raised by the drift. At the 25-foot mark it is 0.43 foot too high, and at the 29-foot mark 0.26 foot too high. The stage was read on this section while in this condition. This section was reset at proper elevation and a new section set from 16 to 26 feet. Section 28.5 to 37.5 was 0.10 foot too high and was reset.

Clarendon, Ark., White River, October 17.—The repairs of the railway bridge necessitated the removal of the gauge a few days prior to the inspection. It was reset at same elevation on a pile a few feet distant.

A duplicate line of levels was run from B. M. 1 (Benyaurd, 1879) and the temporary gauge was found to be 0.07 foot too low.

In order to enable the observer to replace the gauge when bridge repairs are completed, the 18-foot mark was cut in the upper iron cylindrical pier in southeast side of same thus, $\overline{\wedge}$ 18.

Two bench marks were established in trees near gauge.

B. M. No. 1, 1893, is one spike driven vertically into root of leaning birch tree standing at edge of left bank about 75 meters north of Cotton Belt Railway bridge. The tree is blazed and marked 1 with tacks. This bench reads 30.661 feet on gauge.

B. M. No. 2, 1893, is two spikes driven vertically into the land side of a 36-inch leaning willow tree standing on a sloping bank about 62 meters above east end of Cotton Belt Railway bridge; the tree is blazed and marked 2 with tacks. This bench mark reads 21.126 feet on gauge.

The bulletin is placed on the end of a building quite a distance above the bridge where the gauge is located. It should be moved down to the bridge when the repairs on that structure are completed.

Sunflower Landing, Miss., October 19.—Several sections of this gauge were carried away by drift. In order to make it more secure a sloping section extending from 13 to 33 feet was put in on the north bank of the bayou. The other sections were also replaced at the proper elevation. The temporary section in use by observer was found to read 0.27 foot too large. This correction is distributed from 15 feet down to the lowest reading of the season, on the supposition that the error accumulated gradually in transferring from one temporary stake to another.

A duplicate line of levels was run from B. Ms. $\frac{3}{1}$ and $\frac{4}{2}$ to the gauge.

A mean of these determinations gives the elevation of the gauge zero 146.96 feet above the Cairo datum.

A satisfactory determination from the precise-level bench marks would require about 10 miles of leveling.

The bulletin is in good order and the records fair.

This gauge above the 30-foot mark was inspected April 23 and found correct within a tenth of a foot.

An effort was made to connect this gauge with P. B. M. 62 near Lake Charles Landing, but the stone had either been removed or buried to such a depth in rebuilding the levee that it could not be found. A line of precise levels was then run from B. M. $\frac{3}{1}^{8}$ near P. B. M. 62 and connecting with the mile stones on the levee up to B. M. $\frac{3}{1}^{7}$. A large discrepancy (about 2 feet) was found, and it was concluded that $\frac{3}{1}^{8}$ had been raised when the levee was rebuilt. The value of the elevation of the gauge zero at Sunflower therefore still depends on B. Ms. $\frac{3}{1}^{7}$ and $\frac{3}{2}^{7}$, as shown above.

Arkansas City, Ark., October 20.—The different sections of this gauge are scattered over a front of about half a mile. Three new sections reading from 22 to 51 feet were put in just below the site of the elevator, which was destroyed by fire, and with it some of the sections of the old gauge. The sections below 22 feet are on the railway incline.

All of the sections of the old gauge were found to be correct.

A new iron bulletin was erected on the foundation of an old water tank standing just above the railroad depot and on river side of railroad at foot of Fifth street.

The records are carefully kept, and the results at this station are always satisfactory.

The sections above 33-foot mark were examined April 20 and found to be correct.

Greenville, Miss., October 21.—No changes of any importance have occurred at this gauge since last inspection. The low-water section was found to read small 0.11 foot. The others were practically correct.

The descriptions of P. B. M. 1, C. & G. S., should be changed so as to agree with existing conditions as follows: The building on which bench mark is located is now called "City Prison." It stands on the south side of Main street about middle of block east of Locust street. The bench mark is 475 millimeters east of northwest corner of building; 267 millimeters south from north face of building on corrugated iron door sill. The point was marked thus $\triangle$, cut in the iron sill by Assistant Engineer J. A. Ockerson on October 21, 1893. It reads 43.21 feet on gauge.

A pipe and tile bench mark was set on opposite of Main street from P. B. M. 1, and is described as follows:

B. M. O, 1893, is tile and pipe set October 21, 1893, in southwest corner of the block known as the "Blanton Burial Ground." It is near the intersection of Main and Locust streets. It is 693 millimeters north of Main street fence and 621 millimeters east of Locust street fence. The bench mark is copper bolt in upper face of 4 by 18 by 18 inch tile, buried about 3 feet below the surface of ground. The upper surface of tile is marked "Mississippi River Commission $\overset{\text{U. S.}}{\underset{\text{B. M.}}{\triangle}}$." This bench mark reads 37.13 feet on gauge. The tile is surmounted by an iron pipe 4 feet long and 3 inches in diameter, placed over the copper bolt; the cap on this pipe is marked "Mississippi River Commission $\overset{\text{U. S.}}{\underset{1893.}{\text{B.}\boxdot\text{M.}}}$" The top of the cap reads 41.09 feet on gauge.

These benches were set with great care directly from P. B. M. 1, C. & G. S.

The bulletin is in good order and the records are well kept. The sections above 28-foot mark were examined on April 19. The upper section, 35.5 to 45 feet, was replaced by a new section. It was found to be 0.095 foot too low.

The other sections were left intact.

Brunswick Landing, Miss., October 23.—Information was received from the levee engineers at Greenville that B. M. $\frac{3}{1}^{8}$ was in the line of a projected levee. A stop was therefore made at this point and the bench was reset at same elevation and 59 meters farther back from river.

Lake Providence, October 21.—A stop was made at this point, in compliance with a request of Capt. Willard, to ascertain whether any old marks could be found from which the Delta Survey gauge could be connected with the datum now in use. Considerable inquiry among the old residents developed the fact that all of the old town of Lake Providence had caved into the river or was otherwise demolished. The foundation of the "Old Levee Commissioners' Hall" is said to be still intact, but covered by about 18 inches of deposit. An investigation of the levee board records might develop some reference to this foundation, and in that case the foundation could be examined by clearing away the deposit.

St. Joseph, La., October 23.—This is rather a difficult point to maintain a gauge below the high-water section which is spiked to a large cottonwood tree. Nearly all of the sections which were set at the former inspection were destroyed or displaced by drift or steamboats. The observer used temporary gauges set by himself. The stake in the water at time of inspection was found to read 0.13 too small.

In order to furnish the observer with check points when gauge sections are destroyed, hubs were driven firmly into the ground and left projecting but a few inches above the surface. On these hubs, marks were made corresponding to some foot marks on gauge. It is hoped that these hubs will remain intact.

The sections of the gauge were reset from the water surface to the high-water section. The bulletin was repaired. The records were found to be in fair condition.

The sections above 30 feet were examined April 16 and found to be correct within 0.05 of a foot. The observer reports many sections below water line which were set October 23, 1893, have been destroyed.

Bayou Sara, La., October 25.—All of the sections of this gauge below 27 feet are temporary and liable to be knocked down and destroyed by steamboats running over them when submerged. None of the sections placed at the last inspection below 27 feet were found intact. The falling stage from 27 feet down was read on stakes set by observer.

The stake on which observer was reading at time of inspection was found 3.82 feet large. The observer was at a loss to account for this large discrepancy, and could offer no suggestion as to the point where the error might have been made in transferring his temporary gauge as the water fell.

The readings from June to October are therefore to be regarded as doubtful. New sections were put in from −2 to 27. Hubs were also set, similar to those at St. Joseph, to serve as check points for observer. The bulletin is in fair condition and the records neatly kept.

The sections above 31 feet were examined April 14, and section 27 to 42 feet was found 0.047 foot low, but was left intact. The observer reports section 10 to 15 feet destroyed, and reset by water surface checked with spirit level from the next higher section on February 28 and found correct. The bulletin is one of the old pattern and in bad order, and should be replaced by a new iron frame of the approved pattern.

Plaquemine, La., October 26.—This gauge is also at a steamboat landing, and no permanent sections can be maintained below the high-water section. The section in use by the observer at time of inspection was found to be practically correct. Three hubs were set to serve as check points for the observer, who is unusually careful and accurate with his temporary gauges.

The low-water readings at this station are very materially affected by the gulf tides and hence do not give an accurate idea of the stage of the river. The sections above 25-foot mark were examined April 13 and the high-water section was found to be 0.045 foot low. The observer was using a temporary gauge set by himself near his residence, about a quarter of a mile above the site of the gauge proper. This section had been in use about five weeks. It is 0.12 foot too low but was not changed, as a new section, reading from 25.5 to 28 feet, was set at correct elevation near the gauge.

Sections of gauge had been knocked down on two occasions since the October inspection, but were reset from the hubs left for that purpose.

College Point, La., October 26.—This gauge is situated on a prominent point with a gently sloping bank and is remarkable for its stability. A section reading from 11 to 22 and 2 by 6 inches in size has stood practically intact for several years. The other sections are also stable. The high-water section was fixed to the frame of the bulletin. The new levee necessitated the removal of the bulletin, and the section 21.5 to 26.5 feet was reset by observer so as to read 0.07 large. This was reset at proper elevation. The section in the water was found correct.

The remarkable stability of the sections of this gauge suggests that points are preferable to bends as sites for gauges. The points are almost entirely free from drift, caving, and steamboats, which are the active agents in the destruction of the gauges.

The Coast Survey description of P. B. M. XIII is in some respects defective, and as the marks are becoming very indistinct the following description will aid in identifying the bench:

U. S. P. B. M. XIII is a horizontal line cut on two sides of southeast corner of iron post near southeast side of large gateway in front of Jefferson College, at College Point, La. The post stands between the carriage gateway and the foot-path gateway, 3.8 feet west of brick buttress and 17.8 feet east of brick buttress, between which lie the gateways. The bench mark is 4.9 feet above brick foundation on which the iron post stands.

The readings at this point are also affected by the gulf tides. As the readings are taken at fixed times, these times may fall at high tide or low tide, and hence indicate a rising or falling stage, when as a matter of fact the true stage of the river is stationary.

The gauge is carefully watched and the records well kept.

Bank-full stage at this point is about 21.5 feet on gauge.

This gauge was examined on February 9 and no errors were found of sufficient magnitude to justify a change.

Carrollton, La., October 29.—Levels were run in the vicinity of the Carrollton gauge to determine the height of bank-full stage. Outside of levee the average height of bank for a distance of two-thirds of a mile is 11.9 feet on gauge. This is, therefore, the bank-full stage. Inside the levee, average elevation of ground for some distance is equivalent to 7.7 feet on gauge.

Fort Jackson, La., November 23.—The gauge at this point was carried away by the great storm of October 1. It was reset by observer and on date of inspection was found to be 0.267 foot too low.

A new section was set at proper elevation at a point some 300 meters above the old site, where it will be less liable to disturbance. The tidal fluctuations at this point are so much greater than oscillation of river that readings taken at fixed intervals each day are of very little value.

There is no bulletin at this point. The records are in good order.

Fort St. Philip, La., November 23.—This is a much better site for a gauge than Fort Jackson, and as little or no labor was involved it was thought best to establish a gauge on the pier. At Fort Jackson caving is going on which has already carried away the wharf and some of the buildings and threatens further damage; consequently the gauge is in constant danger of being destroyed. It was therefore thought best to erect a gauge on the opposite side of the river with a view to transferring to that point if thought best, or at least to serve as a means of reestablishing the Fort Jackson gauge when destroyed, by setting so as to coincide with Fort St. Philip gauge.

The gauge is spiked to piling at outer end of dock at Fort St. Philip. Elevation of zero is 19.256 feet above Cairo datum.

It should be remembered that nearly all of the gauges are necessarily temporary. High banks which are constantly changing from caving or deposit do not admit of permanent structures. If the sections are not destroyed in this way they usually succumb to accumulations of drift or ice, or the prow of a landing steamer. Add to these the further difficulty of securing observers who have the necessary intelligence and the desire to obtain accurate records of the changes of stage, and it will be readily seen that valuable results can only be secured by frequent and careful inspection.

The gauges at Carrollton, La., Donaldsonville, La., mouth of White River, and St. Louis, Mo., were also inspected and the results reported to Capt. Willard at Vicksburg, who has charge of them.

In connection with the subject of gauges I beg to call attention to the desirability of having all of the gauges under one control.

The location of the different gauges on the Mississippi River and by whom maintained is shown in the following table, giving the location of the gauges, consecutively, from St. Paul downstream.

Location of Mississippi River gauges.

Location.	Distance from Cairo.	By whom maintained.
	Miles.	
Hastings, Minn	895	Maj. A. Mackenzie.
Winona, Minn	797	Do.
North McGregor, Iowa	691	Do.
Hannibal, Mo	334	Do.
St. Louis, Mo	180	Capt. J. H. Willard.
Chester, Ill	108	U. S. Weather Bureau.
Grays Point, Mo	45	Mississippi River Commission.
Cairo, Ill	.....	Capt. J. H. Willard.
Belmont, Mo	21	Mississippi River Commission.
New Madrid, Mo	70	Do.
Cottonwood Point, Mo	123	Do.
Fulton, Tenn	175	Do.
Memphis, Tenn	230	Capt. J. H. Willard.
Mhoon Landing, Miss	277	Mississippi River Commission.
Helena, Ark	306	Capt. J. H. Willard.
Sunflower Landing, Miss	353	Mississippi River Commission.
Mouth White River	393	Capt. J. H. Willard.
Arkansas City, Ark	438	Mississippi River Commission.
Greenville, Miss	478	Do.
Lake Providence, La	542	Capt. J. H. Willard.
Vicksburg, Miss	599	Do.
St. Joseph, La	648	Mississippi River Commission.
Natchez, Miss	700	Capt. J. H. Willard.
Red River Landing, La	765	Do.
Bayou Sara, La	800	Mississippi River Commission.
Baton Rouge, La	833	Capt. J. H. Willard.
Plaquemine, La	854	Mississippi River Commission.
Donaldsonville, La	885	Capt. J. H. Willard.
College Point, La	904	Mississippi River Commission.
Carrollton, La	957	Capt. J. H. Willard.
Fort Jackson, La	1,039	Mississippi River Commission.

A glance at this table shows clearly how the care of the gauges is divided, and it seems to need no argument to demonstrate that all of these gauges should be under the control of one office.

It has been shown above that reliable records can only be obtained at the expense of frequent and thorough inspection. The inspection of the Mississippi River Com-

mission gauges requires a trip from St. Louis to the forts, and in this trip the inspecting and repair party pass by the gauges of Capt. Willard, which alternate with those of the Commission as shown in the above table. At a very slight additional cost all of the gauges could be examined by the same party.

In the Report of the Chief of Engineers, 1893, p. 2059, will be found the following statement of Capt. Willard:

"There are several gauges in each district on Mississippi River between St. Louis and New Orleans, the reports of which are sent to the secretary of the Commission, but the records of all can not be equally valuable, as the gauges are not inspected regularly or uniformly. Rigid inspection is necessary to insure careful observations, to maintain the gauge zeros invariable, and to a well ordered and efficient service, which can be secured in no other way without great cost, and for this reason the recommendation of former reports, that the entire gauge service should be under one management, is repeated in the interest of economy and good service."

The daily stages are recorded at the stations named in the table and published annually by the Mississippi River Commission, and this stage pamphlet is in fact the only publication which contains all of these records. Furthermore, the chief use made of these records is in connection with the works of improvement of the Mississippi River Commission.

The act creating the Commission prescribes in section 3 that "it shall be the duty of said Commission to direct and complete such surveys of said river between the Head of the Passes near its mouth to its headwaters as may now be in progress, and to make such additional surveys, examinations, and investigations, topographical, hydrographical, and hydrometrical of said river and its tributaries as may be deemed necessary by said Commission to carry out the objects of this act."

The gauges now under Capt. Willard were ordered by joint resolution of Congress approved February 21, 1871, as shown in section 5252, Revised Statutes, which says: "The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of * * * and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriations for the improvement of rivers and harbors. * * *"

In view of the above facts, and the statement that the office which now controls twelve out of the twenty-seven gauges on the Lower Mississippi River has no connection with the improvement work of that river, it seems quite evident that the control of all the gauges should rest with the Mississippi River Commission, which is especially charged with the study of the physical characteristics of the river.

MEAN GULF LEVEL AT PORT EADS, LA.

The self-registering gauge at Port Eads gives a continuous record of stage, with but few omissions, since December 8, 1876, and the record at Head of the Passes begins December 8, 1875. The Port Eads gauge is located on the west side of South Pass, about 2½ miles from the sea end of the Jetties.

The records were kindly placed at the disposal of this office by Maj. Quinn, Corps of Engineers, U. S. Army, and much information relative to gauge bench marks and dates of establishing same was furnished by C. Donovan, assistant engineer in charge at Port Eads.

The results at Port Eads, covering the same period as used by the U. S. Coast and Geodetic Survey in determining the mean Gulf level at Biloxi (September 8, 1881, to November 7, 1882), have been reduced by taking the half-hourly readings from the tide rolls and deriving therefrom the mean level as shown in the following table:

TABLE 14.—*Mean of high and low readings for 16 lunations.*

Beginning of period.	Number of readings.	Mean.	Beginning of period.	Number of readings.	Mean.
Sept. 8, 1881	68	2.857	June 23, 1882	54	2.777
Oct. 20, 1881	50	2.870	July 20, 1882	50	2.973
Nov. 15, 1881	56	2.614	Aug. 17, 1882	46	3.011
Dec. 13, 1881	54	2.493	Sept. 13, 1882	50	3.030
Jan. 10, 1882	52	2.753	Oct. 10, 1882	52	2.750
Feb. 7, 1882	52	2.814	Nov. 7, 1882	36	2.138
Mar. 6, 1882	48	2.926			
Apr. 2, 1882	46	3.005	Total		44.967
Apr. 29, 1882	54	2.967	Mean		2.810
May 27, 1882	46	2.989	Weighted mean		2.817

In this investigation it has been found that the mean derived from the half-hourly readings is almost identical with the mean derived from the daily high and low readings for the same period.

The mean of the results in Table 5 gives a mean reading on Port Eads gauge of 2.817 feet. The elevation of the zero of this gauge, derived by duplicate line of precise levels from New Orleans in November, 1893, is 17.733 feet above Cairo datum. Hence the elevation of the mean stage at Port Eads is 20.550.

The relations between the bench marks and the gauge zero at Port Eads in 1881 are the same as in 1894, and the mean stage given (2.817) depends upon the supposition that the elevation of the gauge zero has not changed during that period.

The preliminary mean elevation of Gulf at Biloxi, as deduced by the Mississippi River Commission, is 6.456 feet on Biloxi gauge.

This was obtained by taking the mean stage, June to September, 1882, which period is free from the effects of the high northerly winds.

The mean elevation of Gulf at Biloxi as deduced by the U. S. Coast and Geodetic Survey on same gauge is 6.23 feet. (See Report 1887, p. 200.) This value is the mean stage for the period September 7, 1881, to November 24, 1882, and derived from the same tide rolls as the Mississippi River Commission value.

The line Biloxi to New Orleans was leveled by the Mississippi River Commission in 1882 and 1883. The same line was leveled again by the U. S. Coast and Geodetic Survey in 1886.

Starting with the same elevation for bench at Biloxi the following results were obtained at U. S. P. B. M. 2 at New Orleans:

	M.	Feet.
U. S. P. B. M. 2 by U. S. C. & G. S. levels	2.8055	= 9.2044
U. S. P. B. M. 2 by M. R. C. levels	2.7487	= 9.0181
Discrepancy between the two lines	0.0568	= 0.1863

It will be noticed that the later line of levels makes the bench mark higher, and this is true of all the twenty-five bench marks which are common to the two lines of levels. A change due to the gradual settling of the marks where the ground is soft after the first line was run, producing a difference of the opposite sign, might have been expected.

The differences in elevation of seven successive bench marks (21 to 15) on the solid ground near Biloxi are practically the same by the two lines.

These marks may therefore be considered as quite stable. No satisfactory explanation can be given of the wide divergence between the two lines shown from B. M. No. 15 westward.

Bearing in mind these differences in levels and in mean Gulf level (0.23 foot), as derived from the tide rolls, we deduce the following values of mean Gulf level above the Cairo datum plane:

	M.	Feet.
M. R. C. elevation of P. B. M. 21 at Biloxi above Cairo datum*	6.7111	= 22.018
M. R. C. elevation of 8-foot mark on Biloxi gauge*	6.9501	= 22.802

M. R. C. preliminary value of mean Gulf level on Biloxi gauge, 6.456 feet. (See office report 1860, A I.)

Hence M. R. C. preliminary value for mean Gulf level at Biloxi, above Cairo datum, is 8.000 — 6.456 — 22.802 = 21.258 feet.

U. S. C. & G. S. value for mean Gulf level at Biloxi is 8.00 — 6.23 — 22.802 = 21.032 feet.

P. B. M. 2 at New Orleans above Cairo datum: M. R. C. value = 9.1593 = 30.051 feet; 30.051 feet — 21.258 = 8.793 feet above Gulf level, using M. R. C. preliminary value at Biloxi gauge.

Using the C. & G. S. value of P. B. M. 2 and also C. & G. S. value of Gulf level at Biloxi and we have P. B. M. 2 = 9.2161 = 30.237 feet; 30.237 — 21.032 = 9.205 feet above C. & G. S. mean Gulf level at Biloxi. Difference between the two values = 9.205 — 8.793 = 0.412 foot.

Using M. R. C. value for P. B. M. 2, and we have by the precise levels of 1892 and 1893 zero of gauge at Port Eads, 17.733 above Cairo datum. Mean stage on Port Eads gauge = 2.817 feet (see Table 14); 17.733 + 2.817 = 20.550 feet, which is the mean stage at Port Eads above the Cairo datum, based on the assumption, however, that the zero of the Port Eads gauge in 1881 and 1882 was the same as in 1893.

M. R. C. preliminary value of Gulf level at Biloxi is 0.708 foot higher, and the C. & G. S. value at Biloxi is 0.482 foot higher than this value deduced at Port Eads.

If we use the C. & G. S. value of P. B. M. 2, and the M. R. C. levels of 1892 and 1893 from P. B. M. 2 to Port Eads, we derive for the elevation of the zero of gauge at Port

* See M. R. C. Rep., 1883, p. 70.

Eads: Elevation of P. B. M. 2 at New Orleans = 30.237 feet; elevation of zero of Port Eads gauge = 17.919; mean stage = 17.919 + 2.817 = 20.736, which is 0.296 foot lower than U. S. C. & G. Gulf level at Biloxi.

It has been assumed by many engineers that the mean Gulf level at the mouth of the Mississippi River would be elevated to a certain extent by the addition of the river discharge. If that be true, then the elevation of mean Gulf level at Port Eads should be higher instead of lower, as shown above.

The water of the river is discharged over a fan-shaped area through Cubitts Gap, the Jump, and the several passes. The perimeter of this area is more than 30 miles in length. An inspection of the hydrographs at Port Eads and Carrollton shows plainly that whatever effect on Gulf level at Port Eads can be attributed to the stage of the river there are other influences which are far more potent, and a high stage at the mouth of the river is often coincident with a very low stage of river.

These relations are shown graphically in the accompanying hydrographs.

The Port Eads hydrograph shows a very decided and gradual change in the relations between the Gulf level and the gauge zero with the bench marks to which it is referred.

The most plausible explanation of this seems to be a gradual subsidence of the whole delta.

For this reason the present elevation of the zero of the gauge at Port Eads can not be used to deduce water-level elevations from readings taken in 1881–'82.

If we use the corresponding lunations in 1891–'92 (in 1892–'93 the record is not continuous) shown in Table 6 we have the following results:

TABLE 15.—*Mean of high and low readings for 16 lunations.*

Beginning of period.	Number of readings.	Mean.	Beginning of period.	Number of readings.	Mean
Sept. 8, 1891	25	3.4187	June 5, 1892	26	3.7232
Oct. 4, 1891	26	3.1755	July 2, 1892	28	3.5911
Nov. 1, 1891	25	3.1733	July 30, 1892	25	3.4784
Nov. 28, 1891	27	2.8673	Aug. 26, 1892	23	3.5518
Dec. 25, 1891	23	2.9044	Sept. 22, 1892	21	3.7829
Jan. 21, 1892	26	2.9739	Oct. 19, 1892	18	3.4424
Feb. 17, 1892	25	3.3123			
Mar. 16, 1892	25	3.1054	Total	393	53.7408
Apr. 12, 1892	25	3.4951	Mean		3.3588
May 9, 1892	25	3.7451	Weighted mean		3.3531

Elevation of gauge zero by M. R. C. levels = 17.733 + mean stage for 16 lunations (3.353) = 21.086, which differs only 0.054 foot from the C. and G. S. mean Gulf level at Biloxi in 1881–'82.

These results seem to justify the conclusion that a self-registering gauge at the extremity of the Jetties, 2½ miles farther seaward, would record the fluctuations of the Gulf level and give results not materially affected by the water of the river.

The banks of the Passes are higher above water now than they were in 1876. If the delta is subsiding then this phenomena can only be accounted for on the supposition that the sediment deposit at overflow stages keeps pace and slightly exceeds the subsidence.

Bearing on this question it may be interesting to note that Cubitt's house near the Head of the Passes was built more than thirty years ago. It was set on brick piers 5 feet high. The ground is now up to the sills of the house, and the surface of the ground bears about the same relation to the water in the river as when first built. With reference to the sills of the building the water in the river has grown higher year by year. This is almost universally interpreted by the residents to mean that the bed of the river has risen.

A better and more satisfactory explanation is that of the subsidence of the whole delta on the surface of which stood the foundations of the building which were gradually covered by deposit of sediment. This subsidence and deposit of sediment was not confined to the banks, but applied to the bed of the river as well, and the relative height of bed and banks has not changed materially, and little or no change has taken place in the relative elevations of the bed and sea level.

Physical data.—The record of stages of the Mississippi River and principal tributaries, except the Missouri, for the year 1893 has been tabulated and printed. A copy is appended, marked E. Hydrographs have been prepared showing the daily stages graphically and are appended hereto. Tables of the highest and lowest stages, from the time the respective gauges were established to the end of 1893, are also appended, marked F.

The discharge observations, taken under the direction of the district officers at Columbus, New Madrid, Fulton, Helena, Arkansas City, Wilsons Point, Red River Landing, and Carrollton on the Mississippi River, Clarendon on the White River, Little Rock on the Arkansas River, and Simmsport on the Atchafalaya have been recomputed and the results tabulated.

These results, together with the report of Mr. Kivas Tully, in charge of the computing division, on the methods of reduction, are appended, marked G. The results are shown graphically on plates following this appendix.

This appendix also contains the results obtained by the "Low-water board" in 1879 at Columbus, Clarendon, Alexandria, and Pine Bluff.

PLANT AND OUTFIT.

The steamer *Patrol*, with the survey boat *Illinois*, reached St. Louis on Saturday, May 12. The property pertaining to the outfit was overhauled, and such articles as were unserviceable were taken to the office for inspection and condemnation. All instruments were also transferred to the office.

The articles needed to complete the outfit on board were purchased, and the steamer with quarter boat left on May 16 for Keokuk, arriving at that point on May 20.

Through the courtesy of Maj. Mackenzie the *Patrol* and *Illinois* were put in the Government dry dock at Middle Locks, and repairs to hulls and rudders and general repainting are now in progress and nearly completed.

We are indebted to Maj. Meigs, in local charge at the canal, for valuable assistance in facilitating these repairs.

Very respectfully, your obedient servant,

J. A. OCKERSON,
Assistant Engineer.

First Lieut. GEO. A. ZINN,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

APPENDIX 1 B.

REPORT OF ASSISTANT ENGINEER A. T. MORROW, ON SECONDARY TRIANGULATION FIELD WORK FROM GORDONS FERRY, IOWA, TO PRAIRIE DU CHIEN, WIS.

ST. LOUIS, MO., *October 19, 1893.*

CAPTAIN: I have the honor to submit the following report on the secondary triangulation done by the party under my charge during the summer of 1893.

On May 2 I left St. Louis, accompanied by Mr. George H. French, and proceeded to Keokuk, Iowa, where I procured a theodolite from the steamer *Patrol*. I then went to Rapid City, Ill., to take azimuth observations at the Rapid City base. Two nights of azimuth work were done there on the 9th and 11th of May.

I then proceeded to Galena, Ill., for the purpose of connecting the triangulation of 1892 with a Coast Survey line from Sinsinnawa Mound to Gratiots Grove. I found Gratiots Grove station behind the timber and was compelled to construct a 40-foot station and clear out lines before observations could be taken over lines to Sinsinnawa Mound and Horse Shoe Mound. On the 21st of May, before this work was completed, the steamer *Patrol*, with triangulation party on board, reached the field and tied up at Dubuque. The connection at Gratiots Grove was then completed and the regular triangulation taken up at the line, Ⓐ Horse Shoe Mound and Ⓐ Gordons Ferry, of 1892.

The party was organized as follows: A. T. Morrow in charge, with secondary angles and azimuth observations; George H. French, reconnoissance; C. L. Ockerson, secondary angles; O. N. Axtell, tertiary triangulation and stone lines; T. C. Hockridge, building stations and clearing lines; F. G. Ray and C. M. Talbert, recorders. There was also the crew of the steamer and 12 men.

The work was carried to Prairie du Chien, Wis., and there discontinued on July 25.

With the exception of the extreme heat the weather was favorable, and the health of the party continued good during the whole time. The only serious impediment to the work was the timber which covered many of the hills along the stretch of river covered by the work. The hilltops, which if clear would have furnished the best of locations for triangulation stations, were generally covered with timber too tall to go over and too extensive to cut through.

Instead of being aids to the work they thus became obstructions, which were avoided with much difficulty. The work of locating and building stations became

very laborious and it was only by the most arduous labor of the whole party that a moderate rate of progress could be maintained.

During the sixty-five days consumed by the work the triangulation was carried over a distance of 75 miles, including the Gratiots Grove connection.

Three base lines were measured at East Dubuque, Cassville, and Prairie du Chien.

Azimuth observations were taken at these same points and at Rapids City. Troughton & Simms 10-inch nonrepeating theodolites were used for secondary angles and for azimuth work, and the work was done in accordance with the printed instructions.

Base lines were measured with tape No. 2 of Missouri River Commission, and tension apparatus previously used for that purpose.

Fifty-four permanent bench marks were placed on twenty stone lines, and all were located by tertiary triangulation or directly from secondary work.

After the completion of the work at Prairie du Chien the steamer returned to Keokuk, which point was reached July 29, after having spent two and a half days on the way down in placing tiles under bench marks on the work of 1892.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

Summary of work on secondary triangulation for field season of 1893.

Working days in triangulation season	55
Miles covered by triangulation	75
Secondary stations occupied	53
Triangles closed	54
Base lines measured	3
Azimuth observations (two nights' work each)	4
Stone lines established	20
Bench marks established and located	54
40-foot stations built	11
20-foot stations built	12
14-foot stations built	3
10 foot stations built	3
Ground stations occupied	23

APPENDIX 1 C.

REPORT OF ASSISTANT ENGINEER A. T. MORROW ON TOPOGRAPHICAL AND HYDROGRAPHICAL FIELD WORK FROM NEAR MONTROSE, IOWA, TO KEITHSBURG, ILL.

ST. LOUIS, MO., *October 20, 1893.*

CAPTAIN: I have the honor to submit the following report on the topographical work done by the party under my charge during the months of August and September, 1893:

On July 31 the party on board the steamer *Patrol*, at Keokuk, Iowa, was increased by arrival of several assistants from the St. Louis office and a number of men who had been engaged for the topographical work.

The first day of August was spent at Middle Lock in repairing skiffs and quarter boat and in other preparations for the work in the field.

On August 2, the party was moved up to Montrose, Iowa, and began work on stone line 114, the limit of the topographical work of 1892.

The party was quartered on the steamer *Patrol* and the quarter boat *Illinois*.

The following is the organization of the party: A. T. Morrow, in charge; W. G. Comber and George H. French, shore line; E. L. Harman, Horace Dunaway, E. J. Thomas, C. L. Ockerson, and O. N. Axtell, topography; M. I. Powers and F. G. Ray, ordinary levels; T. C. Hockridge, and C. M. Talbert, hydrography, and C. A. Bonfils, platting. Besides these there were about 40 men employed for the field work, the galley force, and the steamer's crew, altogether making a party of about 63 persons.

With one or two exceptions, which will be hereafter mentioned, the field work has been carried on in accordance with the usual methods which have been frequently described in previous reports.

As the bench marks were already located on this portion of the river, thus giving geodetic points and azimuths every 3 miles, the usual tertiary triangulation was dispensed with and the topography was based on the shore line as located between the stone lines by the shore-line topographers.

The shore-line work on these long stretches between stone lines soon developed the necessity of some substitute for the frequent tertiary flags that had been in use before. Red and white flags were then placed at frequent and conspicuous points on both banks to serve in carrying azimuth more accurately; and at one or more points on the stretch they were placed opposite and near enough to be connected by stadia between the two banks, both shore-line topographers joined on these intermediate points and read over the courses, thus giving definite and reliable points of connection between the work on the two banks.

The improvement in the work was at once apparent, and the connection points, or "C. P. flags," as they were denominated, were thereafter regularly used in our work.

In order to more thoroughly systematize the details of topographical field work and to harmonize the work of the several topographers, the parties were visited in the field and the more excellent points in the practice of the different topographers were observed and taken as a basis for the general practice of the party. At the same time an effort was made to still further improve the field sketches, so that each topographer should carry with him from the ground a complete and faithful representation of the various topographical features, and that they should be so numbered and referred that they could be transferred to the field plats without mistake or delay. The completeness of our later sketches and the increased facility and accuracy with which they are being transferred in the office are evidence of our improvement in that line.

The work proceeded without interruption or delay until September, when several of the members of the party were attacked with malaria in various forms, and before the end of the month sickness prevailed in the party to such an extent as to seriously hinder the work.

On September 30 the work was completed to stone line 132, 1 mile above the Keithsburg bridge, and there discontinued.

On the evening of September 30 the party was paid off at Burlington, Iowa, and the most of the men discharged, a small party being retained on board for the trip down the river.

Appended hereto is a summary of the work done.

I am indebted to my several assistants for their faithful and efficient service.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission

Summary of work.

Work began on August 2, 1½ miles below Montrose, Iowa, and ended 1½ miles above Keithsburg, Ill., on September 30.

Working days employed	52
Miles of river surveyed (channel distance)	63
Topographical parties employed in the work	7
Level parties employed in the work	2
Sounding parties employed in the work	1
Pages of notes taken	4,088
Sheets of field sketches made	263
Square miles of topography	183.67
Square miles of hydrography	30.81
Miles of shore line (including islands and bars)	278.50
Miles dry sloughs and streams (other than main river)	16.75
Miles of bluff line surveyed	67.70
Lines of soundings	508
Casts of lead	22,522
High-water marks leveled to	32
Local bench marks, datums, etc., connected with	47

APPENDIX 1 D.

REPORT OF ASSISTANT ENGINEER A. T. MORROW ON TOPOGRAPHICAL AND HYDROGRAPHICAL FIELD WORK FROM HEAD OF PASSES TO DONALDSONVILLE, LA.

ROCKFORD, ILL., *May 23, 1894.*

SIR: I have the honor to submit the following report on the work done by the topographical party which operated on the lower river, between Donaldsonville and the Head of the Passes, during the winter of 1893 and 1894.

The steamer *Patrol* and outfit reached New Orleans late in October, and on the evening of the 31st of that month I joined the party with 6 assistants and 19 men, making, with those on board, sufficient force to begin work on the extreme lower river. On the morning of November 1, the party left New Orleans and reached the Head of the Passes on the evening of the same day. On the next day the regular work of the season was begun. Assistant Engineer J. A. Ockerson joined the party two days later, and remained until the work was well under way.

As the work advanced the increasing amount of topography required additions to the topographical force, which were accordingly made from time to time until the party had reached its usual size before the work was half completed below New Orleans.

The party, when full, was organized as follows: A. T. Morrow, in charge; W. G. Comber, G. H. French, E. L. Harman, H. Dunaway, C. L. Ockerson, and O. N. Axtell, topography; W. S. Williams and W. H. Roper, levels, and T. C. Hockridge and C. G. Weyl, hydrography. There were also the crew of the steamer and a number of recorders and men, making in all a party of about 60 persons.

The work was completed as far as New Orleans early in January. At that point the topography was so much increased that it was impossible for the topographical force to keep up with the soundings, and a satisfactory progress for that work could no longer be maintained.

The work on Lake Pontchartrain which had been contemplated would still further unbalance the work of the party, if undertaken at that time. I therefore submitted to Assistant Engineer J. A. Ockerson the matter of deferring the Pontchartrain work, in the hope that the soundings might be completed to Donaldsonville before the coming of the high water. In reply, I was authorized not only to postpone the work on Pontchartrain, but to defer the extra work in and about New Orleans and push forward the soundings to the limit of the work, making the work of the force on land conform to the speed of the hydrographical party. I then employed a few extra men, sufficient to work the party to its fullest capacity, and facilitated in every way the work of the sounding crew, leaving so much of the work in and about New Orleans and back topography at other points as was necessary to enable the whole force to keep pace with the soundings. The low-water stage continued until the work had reached the vicinity of Hahnville. Soundings above that point were taken on a slowly rising river. The upper limit of the work was reached on February 21, just in time to escape the high water, which continued thereafter throughout the season.

The party returned to New Orleans on February 22, and prepared to take up the unfinished work in that vicinity.

The heavy rains which had been falling for some time became still worse, and the work was seriously delayed thereby.

In accordance with arrangements made by Assistant Engineer J. A. Ockerson, a sailing yacht, with crew, was chartered for the work on Lake Pontchartrain. A party of 2 surveyors and 8 men was organized for that work, and commenced operations on March 1.

After suffering several weeks from malarial poisoning, I became so ill early in March that I could no longer look after the interests of the party. I therefore telegraphed to Assistant Engineer Ockerson, who came to the field and took personal charge of the party until the work in and around New Orleans was completed and the work on Lake Pontchartrain was well under way. After his return to the office the work on the river was continued under the supervision of Assistant Engineer W. G. Comber and that on the lakes under the direction of Mr. G. H. French. The work on the lakes was completed on April 1, and the members of the party rejoined the force at work on the river.

Donaldsonville was reached and the season's work completed on April 10, when the party returned to New Orleans and was disbanded.

On April 12 the surveyors and a number of men returned by rail to St. Louis and the steamer started on her return trip to the upper river.

TOPOGRAPHY.

The topographical work was begun at the Head of the Passes, and shore line surveys were made to extend one mile down each of the three passes. As the topography in that vicinity was very limited, consisting mainly of shore line and swamp

line, only three topographers were required to keep that work well in advance. As the work progressed and the swamp line receded from the river the topographical force was increased, and a full force of six topographical parties were at work by the time the party had covered half the distance to New Orleans.

During the previous winter a system of tertiary triangulation had been carried over the entire stretch of the work, locating the bench marks on stone lines and precise bench marks between on the part of the river below New Orleans. Besides these, there had been located numerous sugar-house chimneys, church spires, and other conspicuous objects. All these, together with the temporary marks remaining and the old marks of the Coast Survey, formed such a complete basis for the topographical work that it was seldom necessary to run any great distance without some check on the work. The elevations, which were of prime importance in the flat country, were based on lines of levels which were run on both sides of the river following the shore-line topographers, and including the several stadia stakes of the shore-line work. The back topography was based on this front line of stakes, and was generally run in sections or circuits of two consecutive sections, beginning and ending on the front line of stakes.

At places on the lower portions of the work there were many orange groves. It was found more expeditious to run the topography by lines parallel to the river, in which cases frequent connections were made with the front lines, in order to check the elevations of the back topography. The topography was carried back to the swamp and the swamp line located, except in a few places where ridges extended for several miles back into the country. In these places the topography was carried back to a distance beyond the limit of the adjacent topography.

Surveys were made of all outlets, bayous, canals, lakes, etc., coming within the scope of the survey, and in some instances these surveys were carried to a distance beyond the ordinary limits of the work.

An especial endeavor was made to give a complete representation of the levees, and all levees were located and represented on the sketches, both those on the front and those on the back of the plantations. Frequent cross sections of the levees were taken, together with elevations from the river bank to the ground back of the levees.

Much attention was given to the matter of determining property limits and securing the names of property owners. This work proved to be very troublesome, and in some thickly inhabited districts complete information could not be obtained.

In the vicinity of New Orleans the survey was made complete on the right bank of the river. In New Orleans a survey was made of the city front, of the swamp line back of the city, and the thinly settled suburbs. All this work was based on the triangulation and several traverse lines chained through the streets and connected with geodetic points previously determined. The details of the interior of the city were left to be taken from the recent maps of the city engineers.

During most of the season the atmospheric conditions were not favorable for good stadia work. The platting showed a considerably greater average error than during the previous summer, the work of cloudy weather generally platting long, while that which was done in the sunshine almost invariably platted short. I attribute these errors in the first case to the fact that the boards were marked from determinations made in the sunshine the previous summer, and intended to suit the ordinary conditions of summer weather, and in the second case to the boiling or dancing of the atmosphere in the sunshine, which magnifies the image of the rod and gives readings too small. The boiling of the atmosphere, which seems to be always greatest in winter, was considerably increased on this work by the commingling of the warm air from the land with the cooler air from the surface of the cold water of the river. The average error of azimuths in the topographical work of the season was unusually small, owning mainly, I think, to an improvement in the methods of centering stadia boards. The great number of points previously located by triangulation, which are distributed over the whole extent of the work, enabled the topographers to constantly check their work either by intersection or by direct connection; and by the use of these checks in platting, inaccuracies of the field work were quite thoroughly corrected on the field plats.

In comparative extent and in completeness of details the topographical work of this winter will, I think, compare most favorably with that of any previous season.

LEVELS.

At the beginning of the season a precise level party was organized, under Mr. W. S. Williams, to extend the precise levels of the previous year from the Head of the Passes to Port Eads. The work was begun at the engineers' bench mark at the Head of Passes Light-House and terminated at a bench mark established at the end of the east jetty; connection having been made on the way with the two engineers'

gauges, the engineers' bench mark at Port Eads Light-House and with Mississippi River Commission bench marks at mile intervals along South Pass.

The ordinary levels consisted of a line of levels on each side of the river, which was run behind the shore-line topographers, and connected with all stakes of the main stadia line, all permanent bench marks of the survey, local bench marks, water gauges, and high-water marks. On the stone lines, at intervals of 3 miles, the lines on opposite sides of the river were connected. From Poverty Point to the upper limit of the work cross sections were taken, extending from the river to the swamp, and showing elevations of surface at intervals of 50 meters.

HYDROGRAPHY.

Soundings were taken by sections normal to the course of the stream, as nearly as practicable, and on the average about 250 meters apart.

For a small area just above the Head of the Passes, the soundings were left to be taken from maps of recent surveys made by Mr. C. Donovan, under orders of Maj. Quinn.

From the Head of the Passes to Bohemia plantation the soundings were taken from a yawl and located by transit observations from the shore, as the yawl was too small to carry the observers for the use of sextants. From Bohemia plantation to the end of the work the soundings were taken from a steam launch, and located by sextants, except the first few day's work. In order to more completely check the location of soundings, the course of the sounding boat was directed in a straight line by a flagman on shore. A woven cotton line with a 20-pound lead was used for most of the work, but a heavier lead weighing 30 pounds was used in the deepest water. For the purpose of raising these heavy leads and the great amount of line necessary, often more than 150 feet, and reaching as much as 250 feet, a reel was used, which raised the line and delivered it to the leadsman as fast as he could coil it ready for another cast. By the use of this reel soundings could be taken every minute in water of not more than 150 feet in depth.

As most of the soundings taken indicated a greater depth in the channel than was shown on the old maps, especial care was taken in that work, and every possible means used to insure perfectly reliable soundings. I visited the sounding boat from day to day and inspected the work of the leadsmen until I satisfied myself that the work being done was reliable in every respect. As the soundings of the latter part of the season were taken on a rising river and in a considerable current there might be some doubt as to their entire reliability. Therefore, at the suggestion of Assistant Engineer J. A. Ockerson, some experiments were made, after the conclusion of the work, to still further test the accuracy of the soundings taken in the current. A 10-pound lead was attached to a small wire and as the launch floated down stream soundings were taken simultaneously with this line and the ordinary lead line, the two being suspended about 3 feet apart from the bow of the launch. No perceptible difference was shown between the readings on the two lines, except when the bottom changed, and then the change was first indicated by one line and quickly followed by a similar reading on the other. These experiments were conducted in various parts of the stream and at various depths of water, also in eddies and at the junction of eddies with the main current. The results were the same throughout except along the line where the eddies joined the main current. At these points the experiments failed, owing to our inability to handle the wire line with sufficient rapidity to secure plumb soundings.

SURVEY OF LAKES PONTCHARTRAIN AND MAUREPAS.

The survey of lakes Pontchartrain and Maurepas was made by a detached party consisting of two surveyors and eight men, together with the crew of the yacht on which they were quartered.

The work was begun under Assistant Engineer W. G. Comber, but as Mr. Comber was recalled for service on the river, the work was carried to completion under direction of Mr. George H. French.

The work on Pontchartrain began at Milneburg and extended to the mouth of Pass Manchac. Both branches of Pass Manchac were surveyed, and on Maurepas the work was carried from Manchac southward to Amite River. From Milneburg to West End the work consisted of shore line and topography, and beyond West End of shore line with sketches; and the whole survey was based on three chained lines extending to the shore of Pontchartrain from the triangulation system of the river.

One of these lines crossed the lower part of New Orleans and reached the lake at Milneburg, a second crossed the upper part of the city and terminated at West End, while the third left the river opposite Bonnet Carre Point and reached the lake at Frenier. From Frenier this line was extended along the track of the Illinois Cen-

tral Railroad to Pass Manchac, thus giving a fourth point of connection between the shore line of the lakes and the triangulation system of the river.

Flags were placed at short intervals along the shore and series of angles read from them to insure the more accurate transfer of azimuth; and this work was afterwards checked by azimuth carried by the topographer. Distances were read by stadia and are thought to be sufficiently accurate, since the work was checked at the four points above mentioned and as the atmospheric conditions, over the warmer water of the lakes, were unusually favorable for stadia readings.

The river remained low until late in January, and the stage of water, upon the whole, was exceptionably favorable for the work.

The weather was unusually good until near the middle of February, after which there occurred a succession of heavy rains, lasting nearly a month and seriously hindering the work.

The health of the party, on the whole, was not good, as most of those on board suffered from the effects of malaria at some time during the season. Several cases of serious illness occurred, the most of which were, unfortunately, among the surveyors of the party.

Notwithstanding the hindrances from bad health and bad weather, the party made good progress, and the work laid out for the season was completed within ten days of the estimated time.

I am indebted to my assistants for their cheerful cooperation. I think I have not seen together a more faithful and efficient party of surveyors.

Assistant Engineer W. G. Comber is entitled to especial mention for his energy and fidelity to the work.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

First Lieut. GEO. A. ZINN,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

APPENDIX 1 E.

TABLES OF HIGHEST AND LOWEST STAGES SINCE 1872.

Highest and lowest gauge readings, Mississippi River and tributaries (except Missouri River).[1]

MISSISSIPPI RIVER.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.[2]	Elevation of zero above mean gulf level at Biloxi, Miss.[3]	Highest.					Lowest.				
				Prior to 1893.[4]		1893.		Difference.	Prior to 1893.[5]		1893.		Difference.
				Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Hastings, Minn	882.6	690.79	669.53	Apr. 30, 1881	18	May 6	14.3	—3.70	Nov. 23, 1892	—0.70	Nov. 23	0.1	+0.80
Winona, Minn	784.9	660.34	639.08	June 18, 1880	16.87	May 16	12.6	—4.27	Dec. 30, 1889	—1.33	Feb. 12, Nov. 24	1.1	+2.43
North McGregor, Iowa	679	625.45	604.19	May 31, 1892	15.2	May 10, 11	15.1	—0.1	Nov. 23, 1892	1.1	Nov. 27, 28	0.9	—0.2
Hannibal, Mo	322.1	469.60	448.34	May 17, 1888	21.58	May 28	16.8	—4.78	Jan. 9, 1890	—1.75	Dec. 3–5	—1.6	+0.15
Grafton, Ill.[6]	219.9	233.97	212.71	May 18, 1892	215.85	No record			Dec. 4, 1886, Dec. 28, 1887.	190.05	No record		
St. Louis, Mo	180.9	400.23	378.97	May 19, 1892	[7]35.95	May 3	31.6	—4.35	Dec. 27, 1887	[8]1.02	Dec. 8, 9	0.10	—0.92
Chester, Ill	108.1	[9]361.30	[9]340	May 21, 1892	31.2	May 4	28.4	—2.8	Jan. 15, 1892	—1.8	Low water not recorded.		
Grays Point, Mo	45	321.28	300.02	May 22, 1892	35	May 4, 5	32.50	—2.50	Dec. 31, 1880	0.95	Jan. 1	2.35	+1.45
	Below.												
Belmont, Mo	21.3	[10]287.14	265.88	Feb. 23, 24, 1884	45.80	May 8–10	43.80	—2	Jan. 1, 1888	1.39	Sept. 5, 6	3.95	+2.56
Morrison Landing, Mo.	69	275.80	254.54	Feb. 24, 1884	41.50	May 10, 11	38.70	—2.80	Nov. 11–14, 1879	—0.17	Jan. 16	4	+4.17
New Madrid, Mo	70.3	275.72	254.46			May 10	38.11				Jan. 22	4.12	
Cottonwood Point, Mo.	123	250.62	229.36	Feb. 28, 1883	37.85	May 12, 13	36.55	—1.30	Nov. 7, 8, 1891	—0.40	Jan. 17	1.10	+1.50
Fulton, Tenn	175.4	228.55	207.29	Mar. 1, 1882	36.69	May 15	34.63	—2.06	Jan. 3, 1888	1.60	Jan. 23	4.90	+3.30
Memphis, Tenn	230	203.97	182.71	Mar. 23, 24, Apr. 4, 5, 1890.	35.60	May 15, 16	35.20	—0.40	Dec. 25, 1872	—0.95	Jan. 24	1.80	+2.75
Mboon Landing, Miss.	277.3	181.48	160.22	Mar. 8, 1883	40.20	May 24, 25	37.90	—2.30	Nov. 1, 2, 1892	—2.2	Jan. 23–25	—2.60	—0.40
Helena, Ark	306.5	161.98	140.72	Apr. 30, 1886	48.10	May 25	47.92	—0.18	Jan. 5, 1888	—0.18	Sept. 8	2.65	+2.83
Sunflower Landing, Miss.	352.7	147.08	125.82	Mar. 30 to Apr. 1, 1890.	42.90	May 28	43	+0.10	Nov. 9–14, 1891	2.10	Sept. 8, 9	4.50	+2.40
Mouth White River, Ark.	393.2	128.73	107.47	Mar. 31, 1890	50.40	May 29	49.48	—0.92	Dec. 28, 1872	0.00	Oct. 26	7.80	+7.80
Arkansas City, Ark	438.3	116.44	95.18	June 1, 1892	50	do	50.30	+0.30	Nov. 24, 1887	6.30	do	3.40	+3.10
Greenville, Miss	478.3	108	86.74	do	44.28	do	44.30	+0.02	Nov. 22–24, 1887	1.85	Oct. 26, 27, Nov. 17, 19, 30, Dec. 2.	3.40	+1.55
Lake Providence, La	542.3	89.62	68.36	June 2, 1892	41.90	May 15–17	41.85	—0.05	Dec. 29, 1872	—3.85	Nov. 19, Dec. 2	0.75	+4.60
Vicksburg, Miss	[11]599.3	66.04	44.78	Apr. 24, 25, 1890	49.05	May 22, 23	48.30	—0.75	Nov. 24, 1887	—3.91	Oct. 28, 29	0.30	+4.21
St. Joseph, La	648.3	52.74	31.48	Apr. 23, 1890	45.15	do	44.10	—1.05	Nov. 15, 16, 1891	—4	Oct. 20	—1.60	+2.40

Natchez, Miss	700.3	36.89	15.63	....do	48.60	May 22, 24	46.80	−1.80	Dec. 14, 15, 1872..	0.00	....do	6.05	+6.05
Red River Landing, La.	765.3	23.85	2.59	June 27, 1892....	48.87	June 25-27....	47.72	−1.15	Dec. 15, 1872.....	0.00	Oct. 28-31.....	4.10	+4.10
Bayou Sara, La	799.8	23.95	2.69	June 28, 1892....	42.25	June 24, 25....	41.50	−0.75	Nov. 2-5, 1889 ...	−2.10	Oct. 25.....	0.22	+2.32
Baton Rouge, La.....	833.3	20.06	−1.20	....do	38.45	June 23.....	38.40	−0.05	Jan. 9, 1877.....	0.90	Sept. 14, Dec. 4, 5.	2.65	+3.55
Plaquemine, La.....	854.1	21.06	−0.20	June 13, 1892....	33.50	....do	33.75	+0.25	Nov. 13, 1891	0.20	Dec. 5-7	0.80	+0.60
Donaldsonville, La.....	885.4	[10] 19.48	[10] −1.78	....do	30.15	....do	30.60	+0.45	Nov. 6, 1891	1.70	Dec. 4	1.90	+0.20
College Point, La	904.5	21.24	−0.02	....do	25.62	....do	25.90	+0.28	Oct. 21, 1891.....	0.00	Dec. 7	0.05	+0.05
Carrollton, La	957	20.91	−0.35	June 10, 1892....	17.35	June 22.....	17.45	+0.10	Dec. 27, 1872.....	−1.60	Dec. 8	0.30	+1.90
Fort Jackson, La.....	1,039	19.26	−2	Mar. 31, 1891	6.9	June 15.....	6.70	−0.20	Nov. 30, 1891, Nov. 20, 1892.	0.50	Dec. 7	0.30	−0.20

[1] For additional data concerning these gauges see Mississippi River Commission annual pamphlet of river stages.

[2] The Cairo datum plane is 337.931 feet below U. S. P. B. M. 1, 1876, at Cairo, Ill., Survey Mississippi River.

[3] The preliminary value of mean gulf level at Biloxi, Miss., is 21.26 feet above the Cairo datum plane.

[4] Since 1871.

[5] Since 1870.

[6] No record after September, 1892.

[7] High water of June 28, 1844 = 41.4.

[8] Low water of December, 21. 1863 = 0.0

[9] Preliminary value.

[10] From level connection with P. B. M. 10 and B. M. 3/3; May 8, 1894, this elevation is 286.85.

TABLES OF HIGHEST AND LOWEST STAGES SINCE 1872—continued.

Highest and lowest gauge readings, Mississippi River and tributaries (except Missouri River)—Continued.

TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA.

River.	Station.	Approximate distance of station from—	Elevation of gauge zero above Cairo datum plane.[1]	Elevation of gauge zero above mean gulf level at Biloxi, Miss.[2]	Highest.					Lowest.				
					Prior to 1893.[3]		1893.			Prior to 1893.[4]		1893.		
					Date.	Gauge reading.	Date.	Gauge reading.	Difference.	Date.	Gauge reading.	Date.	Gauge reading.	Difference.
		Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas	Little Rock, Ark.	Mouth..176	241.55	220.29	May 21, 1892	31.20	May 3	27.20	—4	Oct. 23, 24, 1879	—1	Nov. 10–20	4.20	+5.20
Do	Pine Bluff, Ark.	Mouth..110	[5]199.80	[5]178.54	May 22, 1892	35.60	May 5	33.70	—1.90	Nov. 20–23, 1887	4.70	Nov. 19	7.10	+2.40
Atchafalaya	Barbre Ldg., La.	Head ... 0	24.17	2.91	Mar. 27, 1882	49.90	June 26–28	48.70	—1.20	Sept. 18, 1881	—1.20	Nov. 18	0.80	+2
Do	Simmesport, La.[6]	Head ... 4	24.17	2.91	June 24, 1892	46.64	No record			Nov. 8, 1891	—1.60	No record		
Do	West Melville, La.	Head ... 27	20.17	—1.09	1882	37	June 27–30	35	—2	Sept. 16, 1887, Nov. 7, 1891.	1.50	Nov. 17–18	3.60	+2.10
Cumberland	Nashville, Tenn.	Cairo ...266			Jan. 22, 1882	55.30	Feb. 22	40.80	—14.50	Oct. 15, 16, 1878	—0.40	Sept. 8–11, 23, 24, Nov. 3.	0.60	+1
Illinois	Beardstown, Ill.	Mouth.. 76	[7]444.26	[7]423	1882	21.3	Mar. 14–15	17	—4.30	Aug. 11, 12, 1887	0.00	Oct. 4, 5	5.40	+5.40
Ohio	Cincinnati, Ohio	Mouth..504	447.62	426.36	Feb. 14, 1884	71.06	Feb. 21	54.58	—16.48	Sept. 18, 1881	1.92	Aug. 29, 30	3.58	+1.66
Do	Louisville (Upper), Ky.	Mouth..364	[8]419.76	[8]398.50	Feb. 16, 1884	46.60	....do	28.80	—7.80	Sept. 10–14, 18–22, 1881.	1.70	Aug. 24, Sept. 4.	2	+0.30
Do	Louisville (Lower), Ky.	Mouth..364	[8]392.85	[8]371.59	....do	72	Feb. 22	54.40	—17.60	Oct. 17, 18, 1872	1.60	Sept. 1, 2, 3	3.10	+1.50
Do	Paducah, Ky	Mouth.. 45	308.40	287.14	Feb. 23, 1884	54.25	Feb. 27	44.3	—9.95	Dec. 29, 1876, Sept. 15, 1887.	.25	Sept. 4, 5	1	+0.75
Do	Cairo, Ill.	Mouth.. 1	290.84	269.58	Feb. 27, 1883	52.17	May 9	49.33	—2.84	Dec. 24, 1871	—1	Sept. 5	4.62	+5.62
Ouachita	Camden, Ark	Mouth Red River 485	[8]96.69	[8]75.43	1882	46	Jan. 5–6	34.80	—11.20	Aug. 29, 30, 1887	1.80	Nov. 4	2.70	+0.90
Do	Monroe, La	Mouth..271	[8]51.55	[8]30.29	1874	49.10	Jan. 9–11, 13–15.	40.20	—8.90	Oct. 17–23, 1887	0.10	Nov. 3–5	1.10	1
Red	Fulton, Ark	Mouth..676	244.78	223.52	July 17, 1876	35.75	Mar. 13	26.80	—8.95	Sept. 7, 1887	0.60	Nov. 20	3.35	+2.75
Do	Garland, Ark	Mouth..618	223.44	202.18	May 24, 25, 1892	28.40	Mar. 13, 14	25.70	—2.70	Nov. 20, 1891	2.12	Nov. 19, 20	1.69	—0.43
Do	Shreveport, La.	Mouth..456	[8]161.27	[8]140.01	May 28, 1892	35.70	Jan. 1, 2	29.10	—6.60	Oct. 13–15, 1892	—2	Oct. 1, 2, and Nov. 20.	—2.60	—0.60
Do	Alexandria, La	Mouth..139	64.46	43.20	June 12, 13, 1892	38.25	Jan. 7	32.25	—6	Sept. 29, 1881	—3.70	Nov. 20	—1.40	+2.30
St. Francis	Wittsburg, Ark.	Mouth..180			Apr. 28, 1886	42.02	May 20–23	40.10	—1.92	Oct. 27–31, Nov. 10–14, 1892.	—3.60	Sept. 21, 22, 27, Oct. 3.	—2.30	+1.30

Do.....	Bridge, St. Louis, Iron Mountain and Southern Ry.	Mouth..194	.....	.....	.....	.....	May 21, 22 ..	41.10	.....	.....	.....	Sept. 23–25..	(?)1	.....
Tennessee...	Chattanooga, Tenn	Cairo ...532	[7]651.90	[7]630.64	Mar. 1, 1875	[9]54	Feb. 20.....	33.40	—20.60	Sept. 11–14, 1881, and 19, 1883.	0.00	Aug. 28, 29–31.	1.60	+1.60
Do.....	Florence, Ala	Cairo ...345	.....	.....	Jan. 22, 1882.....	[10]29.60	Feb. 17.....	21.40	—8.20	Sept. 18, 1878....	0.76	Aug. 31, Sept. 1.	1.10	+1.86
Wabash	Mount Carmel, Ill.	Cairo ...252	[7]397.81	[7]376.55	Aug. 7, 1875	28.3	May 8, 9	24.50	—3.80	Nov. 7–9, 1891 ...	0.4	Sept. 4–29 ...	0.80	+0.40
White	Jacksonport, Ark.	Mouth..360	.....	.....	Mar. 14, 1890	33.35	May 3–5	31.15	—2.20	Dec. 24, 1872.....	—1.10	Sept. 23, 24, Nov. 14–22.	1	+2.10
Do.....	Clarendon, Ark...	Mouth..134	.....	.....	Mar. 20, 1890	36.63	May 11	33.95	—2.68	Nov. 22, 1887	4.07	Nov. 16–19, 20.	6.50	+2.43
Yazoo	Yazoo City, Miss .	Mouth.. 65	[11]93.343	[11]72.083	1882.....	36.50	May 23, 24 ..	25.60	—10.90	1875.....	—4.30	Nov. 3–9	—1	+3.30

[1] The Cairo datum plane is 337.931 feet below U. S. P. B. M. 1, 1876, at Cairo, Ill., survey Mississippi River.
[2] The preliminary value of mean gulf level at Biloxi, Miss., is 21.26 feet above the Cairo datum plane.
[3] Since 1871.
[4] Since 1870.
[5] Doubtful.
[6] No records since May, 1892.
[7] Approximate.
[8] Preliminary value.
[9] High water of 1867 = 58.05.
[10] High water of 1867 = 31.1.
[11] Capt. Willard's precise level value, reported in 1894.

APPENDIX 1 F.

FIELD REPORTS ON DISCHARGE MEASUREMENTS, AND REPORT OF ASSISTANT ENGINEER KIVAS TULLY ON THE REDUCTION OF DISCHARGE OBSERVATIONS, WITH TABULATED RESULTS OF SAME, AND PLATES SHOWING RESULTS GRAPHICALLY. ALSO, RESULTS OF DISCHARGE OBSERVATIONS MADE IN 1879 FOR THE "LOW-WATER BOARD."

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REPORTS UPON FIELD WORK AND FINAL REDUCTION OF DISCHARGE OBSERVATIONS OF 1893, MISSISSIPPI RIVER AND TRIBUTARIES.

FIELD REPORTS.

[Extracts from reports of Mr. A. F. Kilpatrick, chief of party, upon field work of discharge observations at Columbus, Ky.]

I.

MEMPHIS, TENN., *March 29, 1893.*

I have the honor to submit the following, with the accompanying maps and notes, as a report on discharge observations made at Columbus, Ky., in February and March, 1893, by the subsurface or double-float method. As finally organized on February 18 the party consisted of assistant engineer, 2 transit men, and 2 skiff men. During observations use was made of tugboat *Cora Belle* and crew. Transits were used to locate floats and soundings. In timing floats a stop watch was used. Soundings were made with a 12-pound lead up to and including February 27, and with a 16-pound lead afterward.

The field work of locating soundings and floats was done in the usual manner. It is hoped that the maps and notes herewith submitted are so explanatory that a detailed description of the method of getting results is omitted.

Pains were taken in all parts of the work and especial personal care was exercised in having the subsurface float travel middepth the stream at each place, and in accurately timing the floats. In the tabulated slope sheet herewith some omissions are to be noticed in the surface velocity columns due to prevailing winds at the time, although on same dates little or no wind is reported. Apparent inconsistencies in "sine of slope inclination" is also mainly due to variable winds. It was desirable to have the upper and lower gauges farther removed from the section, but impracticable on account of the slowness of tugboat. As heretofore practiced the difficulty was in reading the gauges (when so close together) with the necessary degree of accuracy.

As per your instructions, observations were discontinued on March 6. Levels and check levels were run on the 7th, and party disbanded on following day.

II.

MEMPHIS, TENN., *June 5, 1893.*

I have the honor to submit with notes, maps,* and tabulated results, the following report on discharge observations at Columbus, Ky., in May, 1893:

The same discharge section used in February and March of this year was used for this series of observations.

Soundings were made with a three-eighths-inch woven line and 16-pound lead, and velocities ascertained with subsurface floats of pattern used in 1892–'93.

An effort was made daily to have the floats, numbered 1, 2, 6, etc., cross the section middepth the channel at points 1, 2, 3, etc., on the line A. B. By means of transits at E and C and the parallel line 550′ above the section, floats were started approximately on perpendiculars to the section at said points respectively, with the submerged part suspended middepth the channel at said points as found the preceding day. * * * The first and last floats were started by estimating distances from shore and at constant depths of 15 feet and 8 feet respectively.

The tugboat *Cora Belle*, used during the observations, was not powerful enough to stem the current except under favorable conditions, although otherwise well suited for the work. On this account the desired number of floats and soundings could not always be obtained, and surface velocity observations, except at the section, had to be omitted.

Work is often interrupted by passing steamers, showers, and temporary strong winds. So it is very desirable to have a boat which can do all required in spite of several hours delay. * * * On the 20th of May, when the water had fallen 2.5′ from highest stage reached, observations were discontinued. Levels, connecting gauges, were run on May 21, and the party disorganized.

Capt. S. W. ROESSLER,
Corps of Engineers.

[Extracts from reports of Mr. C. W. Sturtevant, chief of party, upon field work of discharge operations at Fulton, Tenn., 1893.]

I.

AMELIA, ARK, *April, 1893.*

I have the honor to submit the following report upon the measurement of the discharge of the Mississippi River at Fulton, Tenn., during February and March, 1893:

The ganging section was moved downstream on account of eddy water along the Arkansas shore at the old location. The Tennessee end of the section used is 1,020 feet below Fulton landing.

Soundings were taken with a 65-pound lead weight suspended by piano wire from an iron reel; no tags were used on the wire, the weight being lowered to bottom just as the steamboat *Itasca* crossed the range; the number of turns of the reel was counted that was necessary to raise weight to surface of water, and a table of depths corresponding to each turn of crank is recorded in the notes; six turns of crank revolved the iron reel once. The circumference of drum was 6.770 feet. The soundings were located by the intersection of two transit angles intersecting the mast of the boat at the instant it crossed the range, a flag being waved on the boat at this moment. Velocity of the water was measured by a double float, consisting of a middepth and surface float joined together by a string whose length was such that the middepth float would sink half way to the bottom and the surface float be on top of water.

The middepth float was two sheets of tin riveted to each other at their centers and then bent so as to present the most surface to the water but sink rapidly.

The surface float was two tin water-tight cones joined base to base and carried a wire on which was a white flag 6 inches square.

On map,* let A D represent the section on which soundings were taken, one transit being located at B (1,950 feet below discharge section), and the other at C (1,766 feet above discharge section). Range signals were erected on shore back of A on line A D.

The range lines F G and E H, parallel to, and 200 feet from A D, were marked by signals on Arkansas shore. When taking velocity observations, the *Itasca*, with skiff in tow, would go about 500 feet above A D and turn skiff loose, after which the float would be placed in water and the skiff kept along side of it, so that the man with the flag would cross the ranges F G and E H at the same time as the float. Just before arriving on each range the flagman in skiff would raise his flag and at the instant the float crossed the ranges bring his flag down sharply as a signal to the two transits at A and F to locate.

This was the method used except the first nine observations taken March 6, which

* Maps not printed.

were taken as follows: A telegraph line was erected joining B E and F; two electric bells were placed in circuit at B and F. Two telegraph keys were also placed in circuit at E and F. At the instant the float crossed range F G the transmit man at F closed his key and the bells rang, which signaled the transit man at B to locate. When the float crossed the range E H a man would close the key at E, causing the bells to signal both transit-men to locate from F and B. This method worked very well until floats were in middle of the river, when the man at E could not tell when float crossed range or follow it at all with a field glass. If another transit had been available it would have been a success. * * *

Surface floats were run at gauges 1, 2, and 4, and gauges 1, 2, 3, and 4 were read on each day that observations were obtained after February 28.

Gauge 1 was 4,500 feet below the section; gauge 2 was on the section; gauge 3 was about 13,000 feet above the section, and gauge 4 was about 6,400 feet above gauge No. 3, all gauges being on the Arkansas shore.

At gauge No. 1 floats were run between two ranges 450 feet apart. At gauge No. 2, 200 feet apart. At gauge No. 3 no floats were run. At gauge No. 4 the ranges were 198.8 feet apart. Only the maximum surface velocities were calculated at each range.

II.

AMELIA, ARK., *May 27, 1893.*

I have the honor to transmit herewith inclosed original notes of discharge observations taken at Fulton, Tenn., in May, 1893.

The large cross-section area on May 10 seems excessive. The increased depths were noted at the time of sounding, and received my personal attention at that time. They are correct.

The method of taking discharge was the same as used in February and March, 1893, the same points being used as before.

Capt. S. W. ROESSLER,
Corps of Engineers, Memphis, Tenn.

[Extracts from report of Mr. William Gerig, chief of party, upon field work of discharge observations at New Madrid, Mo., February-March series, 1893.]

AMELIA, ARK., *May 2, 1893.*

I have the honor to make the following report on the high water discharge observations made near New Madrid, Mo., February and March, 1893:

The party aboard the steamer *H. L. Abbot* proceeded to New Madrid, Mo., arriving there on February 20 and immediately erected signals and took a discharge by the meter method, meter No. 29 being used.

The party consisted of one assistant engineer in charge, one instrument man, pilot, steam engineer, leadsman, and boat crew.

The observations were made on a section which has almost the same location as the one used in 1888 and 1889, with the exception that the Kentucky end was moved upstream about 200 feet, the Missouri end of the section remaining the same. At the end of the section on the right bank a base line 5,428.2 feet long was measured and checked, nearly at right angles to the section. At the end of this base signal C was erected, but not being high enough, D was erected and used after February 21, 1893.

Radial signals were also erected along the bank with D as the back signal to determine the location of the velocity stations. These locations were all checked by sextant angles and recorded in the field book.

Signals were also erected on the section to determine the river width from day to day, the distance between these signals A and B being 6,285.6 feet. The distance from the water's edge to these signals was measured each day, which determined the river width.

Your instructions were to make a set of float observations in addition to the meter observations every other day or third day. The double float system was used, the submerged float being a pine box 30 by 14 by 12 inches, weighted and lowered to mid depth, the weight being sufficient to hold the double cone-shaped tin-surface float in a vertical position. The floats were located with two transits on the right bank of the river. The method of making the observations with the floats was the same as used by me at Helena, Ark., during the low water of 1891. The observations were made as often as the weather permitted.

The arrangements and method of procedure during a meter observation were the same as previously used in this district, the meter being always lowered to the six-tenths depth. On January 31 and Febuary 1, 1893, meter No. 29 was rated. This was the meter used at New Madrid.

The method of rating the meter was as follows: A wire cable was stretched across a lake of still water in chute of Island No. 30. The meter was attached to a gas pipe which was suspended from the cable, the gas pipe having a small iron pulley attached to it so it could be drawn over the cable with less friction.

The meter being about 3 feet under water was then drawn back and forth over this cable at various velocities, the maximum velocity obtained being 10.89 feet per second. In order to get a uniform velocity two reels (2½ feet diameter) were used, one at each end of the base to draw the meter back and forth. A base line 201.3 feet long was measured along the cable and long poles driven in to locate the ends of the base. To these poles a piece of sheet copper was attached, which projected over the wire cable and about 3 inches above it, and when the meter arrived at either of these points an electric circuit was made through wires leading from the poles to the register and through the copper sheet and the gas pipe to the cable, then back to the register. In order that the exact "start and stop" of an observation be recorded an independent circuit must be made, and hence a third point was placed in the register. This was done by attaching the register to a board and then taking a sounder and placing it on a small box or block alongside the register in such a position and at such an elevation that a wire fastened to the armature of the sounder projected over the tape. A pencil fastened to this wire made a mark on the tape when the circuit was closed through the sounder; the circuit being closed as long as the copper strip or sheet is in contact with the gas pipe.

The ends of the base were about 40 feet out in the water on each side so as to give the meter a chance to be revolving before it got to the end of the base. The depth of the water along the base line was from 5 to 15 feet. The velocity was not entirely uniform over the base, especially during the highest and lower velocities, since the sag could not all be taken out of the cable without breaking it, and the meter traveled the first half of the base faster than the last. The sag was not greater at any time than 6 inches, i. e., the perpendicular distance. Sixty-two observations were made. * * * I think the sag in the wire partly caused the variation in the revolution of the meter.

The observations for a velocity varied from two to four minutes, generally about 150 seconds, when taking a discharge. The meter was tested every day by spinning it and noting the number of seconds it would run.

The lead line was a cotton-braided five-sixteenths-inch line and a 12-pound lead. It was tested every day. On February 27 and 28 check soundings were made with a No. 17 steel piano wire and a 60-pound lead.

Some of the discharges obtained by the meter method are larger than those obtained by float method. This is due to the fact that the current is not normal to the section, being deflected by bars above and below the line. A better location could not be found in this reach.

In determining the slope, the New Madrid gauge in St. Johns Bayou was used as the upper gauge and a lower gauge was established about 1,800 feet below the section on the Missouri shore. The distance between the gauges along the Missouri shore was 26,500 feet.

The velocity at the lower gauge was about the same as at the section and taken to be the same.

Capt. S. W. ROESSLER,
Corps of Engineers.

[Extracts from report of Mr. William Gerig, chief of party, upon field work of discharge observations at New Madrid, Mo., and Helena, Ark., May and June, 1893.]

MEMPHIS, TENN., *June 13, 1893.*

I have the honor to make the following report on the discharge observations made at New Madrid, Mo., and Helena, Ark., during May and June, 1893:

At New Madrid, Mo., the section and signals were the same as used in February and March, 1893, except that the bank has caved on both sides at the section and was going on while we were occupying the same, hence the changes in the river width.

The instruments in use and method of making the observations were the same as explained in my report of May 2, 1893. The same meter rating was also used. The meter was always submerged to the six-tenths depth. * * *

On May 12 two leads were used in making the soundings, one on each side of the boat; the observer with the sextant being on the roof, walked back and forth so as to stand over the leadsman each time who was casting the lead. By this means the soundings were made at less distances apart. The leads used weighed 16 pounds, and three-eights-inch cotton-braided line, the foot marks being painted thereon.

On May 11 check soundings were made with a 60-pound lead and piano steel wire.

Soundings were also made at the same instant with the ordinary lead line, and the two sets agreed very closely, since the water was shallow here.

As the river got higher the current became more normal, and hence the difference between the two methods (floats and meter) was less.

At Helena, Ark., the same section and signals as used and erected by Assistant C. W. Stewart in March, 1893, and later by Assistant Gardner, were used. Assistant Stewart had arranged twenty signals on the Arkansas bank, so that a constant sextant angle of 14° 2′ gives a known location of the velocity station. The angles and distances from signal A to the other signals were measured and the distance out along the section determined.

The head signal used for locating the soundings was No. XX.

The same instruments and methods of procedure were used as at New Madrid, Mo.

The float and meter methods of determining the velocity at this station agree very closely.

The current was normal to the section with about two exceptions: at stations where the velocity was taken, i. e., at two velocity stations the current was not normal to the section, but since they were on the bar and the current was sluggish, and the partial section or area small, the effect on the total discharge was also small.

Capt. S. W. ROESSLER,
Corps of Engineers.

[Extracts from report of Mr. M. Gardner, chief of party, upon field work of discharge observations at Helena, Ark., May 9 to 23, 1893.]

MEMPHIS, TENN., *June 24, 1893.*

I have the honor to make the following report on the discharge observations made at Helena, Ark., during May, 1893:

The steamer *H. M. Graham* was used for the work and to furnish quarters for the party. I arrived at Helena on evening of May 8, and took the first observation on the 9th.

The same section and signals that had been erected and used by Assistant C. W. Stewart in March, 1893, were used. Assistant Stewart had erected twenty signals on the Arkansas shore by which to locate the velocity stations. The angles and distances from signal A to the other signals on shore were measured, and the distances out on the discharge section to the velocity stations were computed and recorded in the field books.

The first two days the soundings were located with a sextant using signal XX, calling it F, as the head signal. All soundings after that were located with a transit at G with the zero set on A.

The instruments used were the Price current meter No. 43, submerged six-tenths the depth, and double floats run at mid depth. A 16-pound lead attached to a three-eighths-inch cotton braided line was used in sounding. After each day's sounding the lead line was tested by stretching it out and measuring it with a tape line, and the corrected soundings obtained and recorded in the field book.

The methods of taking the discharge measurements were as follows:

The steamer was taken to Station I and a sounding was taken; the meter was then lowered to six-tenths depth and the observation began. Care was always taken to begin and end the observation when the boat was exactly on range, except in cases where there was an unusual amount of drift in the river. All the velocity stations, after the first day, were occupied two and one-half minutes, and longer if at the expiration of that time the boat was not on range. When Station I was finished the boat was taken to Station II and the operation repeated. After all the stations had been occupied the section was sounded.

In taking the floats the boat was taken to Station I and then run upstream for a considerable distance, so that the float might be lowered into the water and get well started before the angles were taken. Two men in a skiff followed the float, and when it had gotten well started and running at the same velocity as the water, a man in the skiff waved a flag and at the same instant two men on shore with transits, one at A, the other at G, took the angles, and at the end of one minute the flag was again waved and angles taken, thus locating the path of the floats. All the floats were allowed to run one minute, except in a few cases where something obstructed the view of the transitmen. * * * * * * *

The meter used is the same that Assistant Stewart used in March, 1893, and for which the same rating was used.

On May 24 Assistant William Gerig arrived at Helena with the steamer *Abbot*, to relieve the party in my charge and continue the observations. My party was disbanded, and I was ordered to remain with Assistant Gerig, to assist him with the field work.

Capt. S. W. ROESSLER,
Corps of Engineers.

[Extracts from reports of T. C. J. Baily, jr., chief of party, upon field work of discharge observations at Arkansas City, Ark.; also of discharge at Cypress Creek crevasse and flow across Ashbrook Neck and Carters Neck, 1893.]

I.

GREENVILLE, MISS., *April 29, 1893.*

The following report on discharge measurements taken by me during March and April, 1893, is respectfully submitted:

The party left Greenville on March 1 with steamer *Meter* and quarter boat for high-water observations at Arkansas City. The river was then rising rapidly, which rise, however, culminated on the 11th, with 43.20 on the gauge.

Section.—The old range used for several years past was changed; in azimuth swung downstream 6° 40′, its east end being 560 feet, its west 200 feet below the old position. The system of radial targets was also changed. In the field above the engine house, below the town and 1,966 feet above the section, a station 32 feet high was erected so as to be visible from the river over the cars standing on the levee; this was used as a pivot for stations 12 to 21, inclusive. On the Mississippi side targets from stations 4 to 11, inclusive, were placed radial to a pivot 1,388 feet above the range. Besides these, 400 feet above the section on the Arkansas side, was the pivot for stations 22 and 23, while on the Mississippi side one 199 feet above served for station 1, one 398 feet for stations 2 and 3. There were in all 23 meter stations, 150 feet apart.

The river at this point is 3,441 feet broad between top of banks. Station 1 varied from 81 to 49; station 23, 60 to 54 feet from the water's edge.

Relation of section to flow.—The old section was changed in direction in order to eliminate as much as possible the uncertainty introduced into the discharge when the section is not normal to the current. In order to determine the direction of flow, a skiff having a 230-pound weight hung 20 feet below the surface was allowed to drift down the bend, starting in approximately the swiftest water. Simultaneous azimuths every minute were taken on a flag in the skiff by two carefully located transits, and checked by sextant angles from the skiff. The course of the skiff when platted would be nearly the course of maximum flow 20 feet below the surface. Two trials were made on a calm day, the resulting lines being shown on accompanying map.*

The curves of flow as found in the bend will not vary over 100 feet from a true circle. In the two runs the resulting radii are found to be 8,900 and 7,600 feet, respectively. They cross the range at about 5° from the normal. If the east end of the section were swung down river 5° in azimuth, or so as to be radial to the mean centers of curvature of the two curves, it would be perpendicular to the maximum flow as determined above.

Slope gauges.—Distances between slope gauges are all measured along the line of maximum velocity or axis of flow, being projected normally on this line. Five were placed on each side of the river, their distances apart being as follows:

Arkansas.		Mississippi.
2,500 feet	upper to middle	2,050 feet
2,800 feet	middle to section	3,000 feet
1,800 feet	section to middle	2,300 feet
2,350 feet	middle to lower	1,250 feet

Through an error in using elevations of bench marks their zeros were placed at different elevations. They were, however, all read from the top and corrected to read to a gauge zero of 116.44′ Cairo datum. On account of lack of time the extreme upper and lower gauges were read on but three days and with a falling river.

An examination of these gauge heights and local slopes is interesting and shows the following: Due to the reverse curves above, the water surface at the upper gauges is higher from 0.06 to 0.01 feet on the Mississippi than the Arkansas side; at the middle gauges it is practically level; at the section it is from 0.34 on a rising to 0.06 feet on a falling river higher on the Arkansas than the Mississippi side, and this difference increases down the bend until it reaches 0.6 feet 1 mile below the section. With a rising river the slope on the convex side is steep, that on the concave practically level. As the river falls this level line swings down to meet the steeper convex slope, which grows flatter, and the surfaces on both sides are parallel; the hyperbolic paraboloid has reduced to a plane, while the difference of elevation has reduced to 0.06.

These gauges were placed by carefully checked lines, and many of them were doubly checked. Elevations were carried across the river by three crossings made on different days, the mean of over a hundred backsights and the same number of foresights being used, and bench marks connected by these lines. The gauges were corrected according to these crossings, elevations on the Arkansas side being taken as correct.

* Map not published.

The level used was an 18-inch Gurley, with a good telescope; the rod, a Philadelphia, with a large target 8 inches square. By the method employed curvature was eliminated and errors due to refraction reduced to a minimum.

Measurements for velocity.—The first discharge measurement was taken on the 9th and continued until the 13th, when an accident to the engines of the *Meter* compelled their discontinuance until the 18th, when the *Vedette* took her place and was employed the remainder of the season, with very satisfactory results.

Meter stations were occupied two minutes. At first the meter was submerged to six-tenths depth, but later its depth was kept constant at 20 feet. * * *

Soundings were taken at fixed points on the stations and half way between them, being located by transit angles along a 2,000-foot base, giving 34° 30′ as the smallest intersection with the range. Soundings were taken immediately after velocity. With the above exceptions the methods employed were similar to those formerly used, and will be found in previous reports. * * *

Flanking.—Ten measurements of velocity were made by this method and in the same manner as described in my report of low-water measurements taken at Wilson Point last October. The meter, however, was submerged 20 feet. Countings of revolutions were continuous, the passage of each meter station being noted with the time, also kept continuous. * * *

Flankings were taken in both directions. * * *

Floats were run but once, in the afternoon of April 4, lack of time and heavy winds, which generally rose about noon, preventing more of these measurements. * * *

Subsurface floats were run at 20 feet depth, except end ones.

Parallel ranges for flagging and radial ranges for starting were located. The method employed was the same as last year's, the path of the float being determined by two simultaneous transit angles at the drop of a flag from a skiff following the float, three points in its course being thus located.

Meter ratings.—Price meter No. 38 was used throughout. It was rated on the 13th of March at Huntington from a skiff along a 200-foot base. The rating remained constant until April 6, the spinning time being 4 minutes 30 seconds. On the 6th the time changed to 3 minutes 30 seconds, and remained constant at this throughout the remainder of the work. April 10 another rating was obtained near Greenville. * * *

In order to determine whether the centrifugal force developed by the bend would introduce an error into the measurements taken on the regular section auxiliary ones, 1 mile above, where the difference of elevation on the two sides is very slight, and 1 mile below, in the bend, where the difference is great, were set up. Lack of time, however, prevented more than two measurements on the upper and none on the lower. On this upper section the river is broad and shallow; the velocity curve regular.

II.

GREENVILLE, MISS., *June 23, 1893.*

The following report on discharge observations made at Arkansas City, Ark., May and June, 1893, is respectfully submitted:

The party left Greenville on May 3, and the first observations were taken on May 5, the section laid out in March, and described in my former report, being used.

The tug *Parker* was employed for the work, a small barge, 20 feet by 60 feet, being lashed on her port side, so that the stern of the barge was nearly opposite the pivoting point of the tug, with coal bunkers half filled. Over this stern hung the meter. Price No. 38, with a guy line running from the bow, under the barge, to the 234-pound weight. This made the radius of swing for the meter about 20 feet. Meter was submerged 20 feet. * * *

The method of procedure in the field work was as follows:

First. All gauges were read and recorded, with the time. These gauges had the same positions and elevations as the ones used during March and April. * * * Then an observer, with the transit, occupying an elevated station 2,000 feet below the section, steamer would run in as near the Mississippi bank as possible and flank slowly out to station 1, soundings being taken off the barge and located by the observer mentioned above. Station 1 being occupied for two minutes, steamer would flank to station 2, soundings being taken meanwhile. This was continued until each of the twenty-three stations had been occupied two minutes, and the section determined by located soundings taken on the stations and half way between them, or 75 feet apart, when the boat would drop down to the station for the observer, and then start her regular flanking velocity observations, as described in my former report. After a set of these latter measurements (taken in both directions) had been obtained, the field party would return to the quarter boat.

By this method the section was determined at the time the velocity was being determined. The soundings were taken with extreme care, every one being read by the chief as well as the leadsman; an important consideration in over 100 feet of water, when, owing to the necessary sag of the line, too great depths are invariably

obtained, requiring a scant reading of the soundings. It is found that, as a general rule, leadsmen are apt to read a sounding too deep, and require constant checking on this account. The lead used weighed 20 pounds, the line three-eighths inches, 3-strand cotton, thoroughly broken before graduation, and tested every day after sounding and while wet.

The advantages of a tug and barge over the ordinary river steamer for discharge work are many. Perhaps the most important is the fact that the engineer, looking through the door and with his hand on the throttle, can keep the boat on the cross range, while the pilot has only to watch the station targets. The propeller is very sensitive to the least turn of the throttle wheel; much more so than a stern wheel. The tug, being deep in the water, is scarcely affected by even a high wind, and answers the helm instantly, while the barge helps to steady her. The chief can see everything that goes on; an important consideration in this case, and impossible when a large steamboat is employed. It was seldom that she was off range more than 10 feet. The counting of the revolutions of the meter was begun when the pilot and engineer were on their respective ranges, and although continuing for a fixed time, yet ended with the boat in the initial position, the engineer and pilot both noting the time and being careful to be on range at the end of the two minutes. When this did not occur, the station was occupied longer.

A comparison of the discharges obtained by the two methods will show that when the river is in a normal condition the discharge varies but slightly within a short time; but that, when near its limits, immense fluctuations occur within small intervals. This will be better appreciated after an inspection of the velocity curves. These show that when the river is very high the immense flats above will flow out and fill in within a very few minutes of each other, affecting the flow by at least 100,000 cubic feet per second. The abnormal discharge obtained on the 27th by the regular method is reduced over 100,000 by the flanking method taken immediately after, the unusual velocities on the Arkansas side not being found after the second trial. That at the time the observation was being taken there was an unusual flow is clearly shown by the velocity curve and notes.

To determine whether the correct factors were being used in reducing velocities at 20 feet depth to mean velocities, an extended series [consisting of 14 single verticals, taken at seven different places on the section] of observations were made to determine the form of the vertical velocity curve at Arkansas City. The barge being anchored, velocities were obtained for every 5 feet of depth in all parts of the river from a depth of 30 feet to one of 100 feet. All the conditions were favorable for a correct determination of the velocities at different depths. On one day two meters were employed, one of them at a fixed depth of 20 feet, to determine the fluctuation in the current. * * *

The rating obtained May 5 was used through the 17th; on the 18th the meter changed its rate. It was consequently rerated on May 20 and 23, the new curve showing that for velocities below 4.7 feet per second there had been no change whatever, while above that the rate had changed perceptibly. * * *

Two sets of observations to determine direction of flow in the bend were taken. The results are found on the accompanying maps; there is no marked difference between the direction of the flow during extreme high water and what was found last March.

The crevasse in the Cypress Creek levee, station 201, occurred at 4 a. m. May 27, and materially lowered the gauge and discharge at Arkansas City. A measurement taken by me on June 5 showed a width of 1,090 feet and a flow of 87,235 cubic feet.

On May 25 the flow across Carters Neck was measured by Mr. P. L. Lowe. He found a total discharge of 319,000 cubic feet per second, a mean velocity of 2.07, a maximum of 5, a mean maximum of 3, and an average depth of 6 feet.

On June 7 the party returned to Greenville, measuring the flow across Ashbrook Neck en route. Result, 171,476 cubic feet per second, a mean velocity of 1.39 feet, a maximum 4.75, with a mean maximum of 3 feet per second, and a maximum depth of 5 feet. The river had fallen 0.8 foot at Arkansas City, and the mean velocity 6 per cent. This would give the probable flow across the neck at the highest stage as 232,373 cubic feet per second.

Original notebooks, plots of sections, two sheets of ratings (one showing vertical velocity curve), and a map of the river in the vicinity of Arkansas City accompany this report.

Capt. C. McD. Townsend,
Corps of Engineers

[Extracts from reports of Mr. Charles H. Miller, chief of party, upon field work of discharge observations at Wilson Point, La., and at Lake Port, Keigers, Grand Lake, and Wylys crevasses, 1893.]

I.

GREENVILLE, MISS., *April 29, 1893.*

The following report of the observation party stationed at Wilson Point, La., is respectfully submitted:

A party of seventeen (including crew of steamer) was organized March 5, and proceeded to Wilson Point on that day. The targets having been previously set up, the meter was rated and observations began on the 7th and continued until April 8.

Location of section.—As shown on the map which accompanies this report, the section was moved about 250 feet below the range used in previous years; first, to try and get below the eddy on the Mississippi side; and, second, in order to have the range just 2,000 feet below the transit point △ Ruple. The direction was also changed about 4½ degrees, in order to have it more nearly perpendicular to the flow, as evidenced by the flow across the section last season. The range was divided into 150-foot sections, giving twenty-six stations, with the end ones each 57 feet from their respective banks. Float ranges were placed, one 200 feet above and one 250 feet below the discharge range.

Gauges.—As directed, three guages were set on each side of the river; two about on the range, two about 2,000 feet above, and two about 2,000 feet below. (The upper Mississippi gauge could not be moved farther up on account of Skipwith chute.) These were connected by check levels with the Government benches, and the zeros set at 80.32 feet, Memphis datum. These gauges were used to obtain the local slope of the river. The upper slope on Mississippi side is minus on account of the eddy at that place.

The extreme unreliableness of results obtained in this manner can be seen by observing the variable results given in the accompanying slope table.

These gauges can not ordinarily be read with sufficient accuracy, even on calm days; the influence of the steamer will often materially change the results.

Gauges were read as soon as possible after taking soundings.

Steamer.—The *Osceola* was used for taking the observations. She did fairly well in the stronger currents and extremely well in the wind, but in the slack currents there was too much power, and she was too slow in answering to the rudders. On a large number of the stations she could not be worked slow enough but that she would move above the range, which necessitated the stopping of the engines at intervals, thus increasing the difficulty of holding on range.

Rating the meter.—This was done in the slack water at Ashton, La., using the steamer for taking them; for the early ratings meter was lowered only 10 feet beneath the surface. It was found that it was influenced by the boat at this depth, and a final rating was taken with meter submerged 20 feet. This gave a rating practically the same as the one for this meter used last season; and as the meter spun the same length of time as it did last year, this rating was taken as the right one. * * *

Price meter No. 39, spinning between two minutes twenty-five seconds and two minutes thirty-five seconds, was used for these observations.

Leveling across the river.—Two sets of observations were made with ordinary level and rod. The mean of the two checked the published elevations within 0.2 of a foot. Assuming the Mississippi elevation as correct, the Louisiana elevation would read that much too high. This is about the difference, as found from day to day, in the readings on the Louisiana gauge, at the range, over the readings on the corresponding gauge on the Mississippi side. But we can not assume the above levels to be correct within this limit, because of the instruments used.

Regular observations (26 obtained).—These consisted in finding the velocities at the fixed stations, 150 feet apart. They were taken in the usual manner, except that the meter was lowered only 25 feet for the first few observations and 20 feet for the remainder.

The usual time of occupying a station was two minutes. A telegraph sounder was used and the "ticks" counted. The battery consisted of three Le Clanche cells.

For a comparison with method of last season results were worked out each day by taking half the velocity observations—every other one—or the same as taking observations every 300 feet.

Flanking observations (12 obtained).—These consisted in starting on one side of the river and slowly moving across, keeping on the discharge range, having the record running continuously, but noting the registrations and the time as each cross range was being passed. This was repeated at once, but in the opposite direction, and made up one set of observations. The meter was lowered to 20 feet (except March 10, which was 15 feet), except at the ends. * * * The velocity of the current for each section was found by taking the feet per second, as found from the meter registrations, as the hypothenuse and the velocity of the boat as one side of a right-angled

triangle and computing the other or resultant. In some instances, where the boat was off range, these final velocities vary very much, but they generally compensate each other, and therefore give the total discharge nearly correct.

Double float observations (3 obtained).—Taken in the usual manner; subsurface float submerged 20 feet. The connecting cord was of very small size. * * * Thirteen floats, or one every 300 feet, constituted a set. * * *

Soundings.—Taken with a 22-pound lead on a half-inch cotton line. Located by transit, which was placed 2,000 feet above range. Flagman on boat keeping himself on the range by moving back and forth on deck of steamer. During the first part of the time the soundings were taken immediately after the regular observations, but during the last ten days, when flanking observations were taken, the soundings were obtained at the same time that the regular observations were being taken. Soundings taken about 75 feet apart, one on each station, with an intermediate between each two stations. Only one set of soundings was taken on any single day.

Direction of the current.—The paths of the double floats platted on the map show approximately the direction at different places. Also, on one day three observations were obtained, from a half mile above to about the same distance below the range, by means of a rod float 10 feet in length, balanced to stand perpendicular, with but a small part above water. A skiff followed and signaled at intervals of one minute to the two transits on the bank, when angles were read simultaneously on the small flag on top of the rod. These observations gave the current as moving from Mississippi to Louisiana at about an angle of 4½ degrees, with a normal to the range. The double floats in the same part of the river gave similar results. But those double floats nearer the ends of the range gave the current as moving from Louisiana toward Mississippi. * * *

However, these observations taken at a depth of 20 feet would be influenced much more by the water from shallow chutes than if they had been taken at a greater depth, and therefore may not be indicative of the conditions existing at a greater depth.

Boils.—From about station 4 to 6 very large boils were experienced after the river began to fall, and they continued more or less until the end of the observations. On some days they were large enough to materially affect the position of the steamer. It was in this part of the river where the most violent changes took place as regards scour and fill, there being one instance of 16 feet fill in twenty-four hours. Here, also, will be noted rapid changes in the velocities as found from station to station.

Eddy.—This eddy on the Mississippi side extending out as far as station 2½ (500 feet) existed until the river began to fall, when it moved farther upstream and the water at the section began to move downstream, continuing in this direction during the remainder of the observations. No measurement of the flow in this eddy was obtained while the water was moving upstream.

II.

GREENVILLE, MISS., *June 23, 1893.*

The following report of the observation party stationed at Wilson Point, La., from May 4 to June 8, is respectfully submitted:

The party, consisting of fourteen (including crew of steamer), left Greenville on May 3, in tow of steamer *Meter*. Two recorders were added to the party shortly before the end of the work.

Section.—The same section that was in use during March and April was used for this set of observations, all the targets having been found in place.

Gauges.—The same gauges were also used, with but a slight change in the position of two of them. Some trouble was experienced in keeping the upper Mississippi gauge in place on account of the caving banks; and for this reason on some days its reading was not obtained.

The river still shows a warped surface, the same being more pronounced than during the previous observations, which were at a lower stage of the river. The two lower gauges showed about the same reading, while the upper gauges gave a difference of from 0.6 foot to 0.7 foot. Probably most of this difference is due to the eddy on the Mississippi side; this eddy rarely extended as low as the section, however.

In checking the Louisiana gauges used last year, they were found to be just about one-tenth too high, and were lowered this amount during the observations of March and April. Therefore, to obtain the correct readings for gauges during 1892 observations, add one-tenth foot.

Steamer.—The steamer *Meter* was used for all the observations, and is a very marked improvement over the *Osceola*.

Rating of the meter.—A rating for high velocities was taken in the slack water at Ashton, La., on May 4; steamer was used: meter submerged 20 feet. There was a slight current at the time. * * *

The points for low velocities were obtained at Wilson Point, and were taken in

a skiff. As the meter did not change its rate of spinning, the rating was assumed to remain constant; and this one rating was used through the entire set of observations.

Price meter No. 39, spinning between two minutes twenty-five seconds and two minutes forty seconds, was used.

Observations.—These, both regular (150-foot stations) and flanking, were taken in the same manner as described in report of April 29, 1893, except that the motion of the boat during the flanking was much slower than during the previous set. The soundings were taken in the usual manner (described in previous report).

Direction of current.—Two sets of observations were taken with a rod 14 feet long, balanced perpendicularly, 3 trials in each set. The paths were plotted on the map, and are shown on the tracing which accompanies this report.

The general direction is more nearly parallel with the banks, and does not show such a decided "crossing" as the lines taken during March. The difference in the height of the river explains this. * * *

Results.—Generally, the meter was lowered 20 feet. * * * On May 22 two sets of flanking at 40 feet depth were taken, and two sets taken at 20 feet depth, all taken on the same day. * * * On May 30 a set of regular station observations, at about six-tenths depth, were taken during the same time that 20-foot observations were being taken. * * *

Crevasse measurement.—Crevasse at Lake Port took place May 11, 4 a. m.; measured by Mr. Kerr May 13; discharge, 64,726 cubic feet per second.

Crevasse at Keigers May 14, 6 a. m., and one at Grand Lake May 15, 9 p. m.

These three crevasses measured by Mr. Kerr May 20 and a discharge of 159,700 cubic feet found.

On June 10 these three crevasses were measured and gave a discharge of 155,200 cubic feet.

Crevasse at Wylys took place May 23, 11 a. m., and was measured May 29, giving a discharge of 230,200 cubic feet.

Capt. C. McD. TOWNSEND,
Corps of Engineers.

[Extracts from report of Mr. L. L. Griffith, chief of party, upon field work of discharge observations, Arkansas River, at Little Rock, Ark., 1893.]

ARKANSAS CITY, ARK., *May 20, 1893.*

The following report of discharge measurements taken by me in May, 1893, is respectfully submitted:

The observer and recorder left Greenville Wednesday, May 3, at noon, for Little Rock, Ark., arriving at 6 p. m. May 4.

Range.—The next day, with steamer *Eli* and two men, a range was set up as nearly perpendicular to the current as could be determined without knowing its general direction; parallel with this range and 200 feet above and 200 feet below were placed two similar ranges, making the distance traveled by floats 400 feet. A pivot was located 1,465 feet above the discharge section and radial targets were placed so as to intersect the upper range at the points which were perpendicularly above the stations on the discharge section.

Location.—The point selected for the discharge range is 7,710 feet below the Little Rock and Fort Smith Railroad bridge, near the end of a straight reach of river, perpendicular to the range, and 1,000 feet above was located a transit point.

Stations.—The stations were arranged in the center of each of fourteen divisions of the section which were all 150 feet wide, except the end ones, which were 33 feet wide.

Floats.—The observations were taken with surface floats, consisting of two tin cones soldered base to base; inside was placed about 1 pound of shot, which caused the float to be about one-half submerged. Each cone measures 4 inches in height and 6¼ inches is the diameter of the base.

Soundings.—Soundings were taken each day just preceding the observations by floats. A 16-pound lead and one-quarter-inch 3-ply cotton line was used and carefully graduated and tested. Soundings were taken every 75 feet except near the ends, where they were taken closer together.

Method of computing results.—The first measurement was taken May 6, and on each day thereafter to and including May 10, five in all. * * *

The river was falling during the first four observations, but rose one-tenth during the last. On stations 13 and 14 there were a few eddies, probably caused by the dikes above on that side of the river.

The wind on each day was blowing almost directly upstream and varied in intensity, as shown in the table, from very light to brisk. All other conditions except those mentioned were very favorable during all five days.

The highest water had passed before the first measurement was taken. * * *
Gauges.—The U. S. Signal Service gauge was used in all this work.

* * * * * * * *

Accompanying this report I send you a map showing the location of the discharge section at Little Rock, Ark., and a plot showing the section and the directions taken by the floats. * * *

Capt. C. McD. TOWNSEND,
Corps of Engineers.

[Extracts from report of Mr. Luther Y. Kerr, chief of party, upon field work of discharge observations, White River, at Clarendon, Ark., 1893.]

GREENVILLE, MISS., *May 17, 1893.*

The following report on the White River discharge observations at Clarendon, Ark., is respectfully submitted:

On the 3d instant I, with one recorder, was ordered to proceed to Clarendon and make observations for discharge at that point.

The steamer *Vedette* having previously been ordered down from the quarries in Little Red for that purpose was waiting on our arrival the morning of the 4th. The water area at the stage during which the observations were made is about 15,874 feet wide. The only possible place to get a continuous section would be at the bridge and continue it out along the railroad trestle to the high grounds. This, however, was impracticable, as the water immediately above, and to a considerable distance below the bridge, was too much disturbed by the piers to give good results. The section was, therefore, placed about 1,100 feet above the bridge, this being as near as was considered safe to handle the boat, and at a point where the current beyond the timber line was imperceptible and the flow in the river parallel to the bank, so that the observations for bank discharge could be taken up at the bridge without loss or repetition.

Meter stations were located 100 feet apart on the regular section. Observations were taken from steamer by the ordinary method with Price meter No. 5 and electrical apparatus.

Meter submerged six-tenths depth and stations occupied two minutes. * * * The meter stations for the bank discharge were located along the trestle and from 300 to 600 feet apart; the velocity ascertained with the meter, which was submerged 1 foot.

The areas of the separate sections were obtained by taking a mean of the soundings through the section and multiplying by the width, then this result by the velocity obtained in the observation. The first discharge was obtained on the 5th instant, of the river only; the last on the 10th, making five in all. Three sets of observations for bank discharge were taken, 6th, 8th, and 10th. For the total discharge on the 5th, I use the mean velocity found on the 6th, and the area reduced by the difference in gauge reading; for the 9th, interpolated between 8th and 10th. The largest discharge obtained was on the 10th instant, mean gauge reading 33.85 feet. * * *

Capt. C. McD. TOWNSEND,
Corps of Engineers.

OFFICE REPORT.

OFFICE OF THE SECRETARY, *May 14, 1894.*

LIEUTENANT: I have the honor to submit the following memoranda to accompany the tabulated results of final reduction in this office of discharge observations of 1893.

The observations on the main river are made by the district officers under direction of the Mississippi River Commission and the field notes are sent here for official computation. Field reports, plats, and maps of location, generally accompany the notes. The parts of these reports relating to the field work have been printed on the preceding pages, and also special memoranda for each station are appended hereto.

River stages during observations.—During the year two floods occurred on the main river below Cairo; the first of these, culminating in March, was a moderate one and of short duration; the second, beginning in May, was a very important flood, its height at some of the lower stations surpassing all former records.

Both of these floods were measured in the first to third districts, and in the fourth district the second one only, as the first rise was not so well defined in the lowest district. High water discharge was also measured on the Atchafalaya, White, and Arkansas rivers.

A table of highest and lowest gauge readings for the year at the different localities has been prepared, giving also the previous extreme recorded readings for comparison. The floods are also further described in the report of the commission, 1893. During the low-water season only one river discharge has been reported, that on the Mississippi River at Wilson Point, La., October 24, 1893.

Field methods.—The instruments and methods of observing in the different districts are practically the same as in former years, with the following exceptions in the third and fourth districts: In the third district, in addition to the regular observations prescribed by the Commission, velocity observations were made by the so-called "flanking" method, which was first introduced at the close of the 1892 work; this will be again referred to further on.

A new feature in the fourth district was the use of two parallel discharge ranges at each station, about half a mile apart, and measuring the discharge at each, generally on the same day. This was also done at Arkansas City, but for only two days. In the third district, two gauges were read at the section, one at either shore, both gauges being connected by careful leveling.

Final reduction.—The methods of final reduction are essentially the same as have been in use in this office for several years past for similar observations, and have been fully described in previous reports. Some changes in detail have been made from time to time to accommodate special conditions, or where experience has shown that time and labor can be saved without impairing the value of the results. All the work has been checked, either by comparison with field results or having the work of one computer checked by another at each stage of the reduction; generally the agreement with the field results was not sufficiently close to dispense with the second computer.

When double floats were run at mid-depth the resulting velocity has been taken as the mean velocity in that vertical plane; this relation, however, is not regarded as finally determined.

The vertical component of the float path, with regard to the discharge section, has as usual been taken for finding the velocity.

When the float did not reach the discharge range a line was produced in the direction of the float path and its intersection with the range located the velocity station.

In the three upper districts the velocity observed at a station was applied to the area on either side, halfway to the adjacent stations; in the fourth district, the soundings being only taken at velocity stations, the mean of velocities at each two adjacent stations was applied over the included area in getting each partial discharge. The discharge between the end velocity station and shore was generally computed by taking two-thirds or four-fifths of the velocity observed at the end station. This was determined by the form of the transverse curve of velocities in each case.

The observations for rating the current meters were reduced by the method of least squares in the usual manner, except that in the case of meter No. 38 the reduction was made graphically and tables of equivalent velocities and registrations scaled therefrom. The results of least square reductions are given in a table herewith.

The plan adopted this year in the third district (which includes Arkansas City and Wilson Point) of keeping the meter at a constant depth of 20 or 25 feet below the surface, as was done in both the regular and flanking observations, very much increased the labor of reduction. The factors used to reduce velocities so obtained are given herewith; they are derived from 12 sets of verticals made at Arkansas City during the season and from 843 sets made in 1882 at various points. For Arkansas City these were combined by taking the mean of the two curves. For Wilson Point the 1882 results only were taken, since no observations of the vertical were taken in 1893 at this station. For results of 1882 vertical observations used, see report of the Mississippi River Commission for 1884, p. 189.

At Red River Landing and Simmsport the meter was generally run at mid-depth, except a few days at three-tenths or four-tenths depth, the vertical curve of 1882 at Red River Landing was taken for reduction factors this year.

The "flanking" observations in the third district, before referred to, and described in Mr. Baily's report of last year (see Report, Chief of Engineers, 1893, p. 3672) were made by moving the meter slowly across the river, keeping the boat as nearly as possible on the discharge range, and noting the time and meter registrations as it passed the different stations, the latter being 150 feet apart. This gave the velocity of the boat across the river, and the meter measured the resultant of this motion of the boat and the velocity of the current, in a horizontal plane, generally 20 feet below the water surface. The velocity for each division was found by the following formula: $v = \sqrt{v'^2 - v''^2}$, in which v' = velocity recorded by the meter between the adjacent stations; v'' = velocity of boat between stations, and v the velocity of current in that section at the depth noted. The same tables of vertical factors were used in reducing these as in the regular observations.

In the first and second districts, where the meter was run at six-tenths depth, this depth has been taken, as heretofore, to represent the mean velocity in the vertical.

All the results herein tabulated are from reduction in this office, except the slope and crevasse tables, for which the district-office results are taken, being first checked as far as possible and specially noted in each case. Plates have been prepared for each station, showing the mean velocities, water areas, and discharges, plotted to gauge heights, and also the datum areas, gauge curve, and one or more characteristic profiles of the discharge cross section, and also a map of the river in the vicinity, with the discharge section located thereon.

Very respectfully, your obedient servant,

KIVAS TULLY,
U. S. Assistant Engineer.

First Lieut. GEORGE A. ZINN,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

COLUMBUS, KY.

[For field report, see pp. 2808 and 2809.]

The discharge section is about 300 feet upstream from the Mobile and Ohio Railroad depot in Columbus, and is about 500 feet upstream from upper end of wharf boat, shown on Mississippi River Commission chart No. 4, scale 1:20000. The azimuth of section, right bank to left bank, is 306°. The location is the same as that of last year, except that the Missouri end is moved upstream about 60 feet. The velocities were all taken with double floats.

The observer reports that the floats were of same pattern as used last year; the latter were described as follows: "The float consisted of a double-coned, air-tight tin buoy, with flag, connected by a fine cord with a tin anchor [subsurface float], which consisted of two sheets of tin 20 inches by 14 inches, crossed at right angles, making four leaves or flanges 7 inches by 20 inches. The buoy was 5½ inches diameter, total length 12 inches."

The readings of the Mississippi River Commission gauge at Belmont are given in the table; the zero of this gauge is 286.85 feet above the Cairo datum plane, by levels of Mississippi River Commission party, May 8, 1894, from P. B. M. 10 and B. M. 3. The former published value for this gauge zero was 287.14 feet.

The datum line is taken at 43.81 feet on the Belmont gauge as observed May 9.

NEW MADRID, MO.

[For field report, see pp. 2810 and 2811.]

The discharge section is at Watson Landing, Ky., about 3½ miles below the town of New Madrid, Mo. The Kentucky end is precisely at Watson Landing, shown on Mississippi River Commission chart No. 8, scale 1:20000. Azimuth of section from Kentucky end is 66° 30′.

The location is the same as section of 1888–'89, except that the Kentucky end has been moved upstream about 200 feet.

The gauge readings tabulated are as observed on the Mississippi River Commission gauge at New Madrid by the discharge party. The zero of this gauge is 275.72 feet above the Cairo datum plane. The water surface at discharge section on May 10 was taken as datum line for the datum areas, the New Madrid gauge at the same time reading 38.10 feet.

In regard to the extraordinarily large discharge obtained with the meter March 1, the observer, in answer to inquiry from this office, writes:

"The meter observations of March 1 were all rejected, as they were so large and as the registrations were not uniform, being probably due to false registrations. The meter was examined (at the time), but could find nothing wrong with it."

The chronograph slips were not sent in with the notes, but the mean registrations per second at each station being plotted on the cross section, the same as for other days, gave a comparatively fair transverse curve; the resulting discharge has been tabulated with a note.

Price meter No. 29 was used at six-tenths depth, and was generally run for about 150 seconds at each station. The values of the meter constants are given in tabulated results of ratings herewith.

FULTON, TENN.

[For field report, see p. 2809.]

The discharge section is stated to be 1,020 feet below the landing at Fulton, Tenn.; the landing is shown on Mississippi River Commission chart No. 16, scale 1:20000. The discharge section is about a mile below the section used last year.

The large increase of depth May 10 was noticed in the field and verified; the profile of sections for this day and also for nearest days before and after are given on accompanying plate for comparison.

The tabulated gauge readings are from the Mississippi River Commission gauge at Fulton; the zero of this gauge is 228.55 feet above the Cairo datum plane.

HELENA, ARK.

[For field report, see pp. 2811 and 2812.]

The discharge section is 4,500 feet below the wharf boat at Helena, shown on the Mississippi River Commission chart No. 27, scale 1:20000. Azimuth of section from right bank is 277°.

The meters used were Price No. 43 to May 23, and Price No. 29 from May 24 to end of season. The values used for the constants of these meters are given in table of ratings herewith. The gauge readings tabulated are from the Helena gauge observed by the discharge party. The zero of this gauge is 161.98 feet above the Cairo datum plane. The datum line, for computing datum areas, was taken at 47.90 feet on this gauge as observed May 25, 1893.

The bank discharge tabulated was measured on May 10 and 22, at Eagle Lake railroad trestle, Mississippi side of river; the bank discharge given for other days is derived from these two observations.

ARKANSAS CITY, ARK.

[For field report, see p. 2813 et seq]

The discharge section is about 900 feet downstream from the railroad engine house, shown on Mississippi River Commission chart No. 37, scale 1:20000.

For the flanking discharges, the velocities at ends of section, where the boat could not flank on account of shallow water, were taken as observed by the regular method. The following factors were used in reducing the velocities observed at the different proportional depths to the mean of the vertical.

.1 depth	0.8978
.2 depth	0.8966
.3 depth	0.9081
.4 depth	0.9272
.5 depth	0.9470
.6 depth	0.9831
.7 depth	1.0411
.8 depth	1.0964
.9 depth	1.2339

The Arkansas City gauge readings are from the Mississippi River Commission record; the zero of this gauge is 116.44 feet above the Cairo datum plane. The "local" gauge readings in the standard tables are the means of readings taken on two gauges at either end of section; the individual readings are given in flanking tables.

The datum line is taken at 49.81 feet above the zero of section gauges and is the mean of their readings May 29.

The over-bank discharge tabulated was measured on line of the discharge section, and on both banks between levee and river; this was observed May 8, 12, 18, and 26, and other days interpolated.

WILSON POINT, LA.

[For field report, see p. 2816 et seq.]

The discharge section is about 1,200 feet above Wilson Point Landing, as shown on Mississippi River Commission chart No. 43, scale 1:20000. Azimuth of section from right bank is 253°. This is stated to be about 250 feet below section of previous years, the azimuth being also changed about 4° 30′.

From March 7 to 13, since the observer reports an eddy extending out from the Mississippi shore a distance varying from about 500 to 350 feet, and locates its limit each day on the section, this portion of the section was given zero velocity in com-

puting discharge but is included in the water area. The observer states that there was an upstream current in this eddy, but that he made no observation or estimate of its rate.

In the flanking discharges the velocities for ends of section were taken from the stationary observations, since the flanking observations were generally not carried as close to the banks as in stationary method.

The vertical factors used to reduce velocities observed at different proportional depths to the mean velocity in that vertical plane are as follows:

.1 depth	0.9136
.2 depth	0.9154
.3 depth	0.9269
.4 depth	0.9349
.5 depth	0.9550
.6 depth	0.9897
.7 depth	1.0295
.8 depth	1.0930
.9 depth	1.1959

Two gauges were read at the section, one at either end, the zeros being 93.45 feet above the Cairo datum plane. The mean of readings on these are given under head of "local" gauge in the regular tables, and the individual readings of same gauges appear in the tables of flanking results. Under the head of "Lake Providence" gauge are given the readings of the U. S. engineer gauge at that place; the zero of this gauge is 89.62 feet above the Cairo datum plane.

In the tabulation the Roman numerals give the direction from which wind was blowing, these numerals taken from the face of a watch held on the range, with III toward Mississippi and XII upstream. North is between XII and I.

The over-bank discharge was measured on both banks between main levee and river, but was at different points and not on line of the section; above the section on left bank and below it on the right bank. The bank discharge was observed May 9, 16, and 27, and interpolated for other days.

RED RIVER LANDING, LA.

No field report has been received for this station or for Simmsport. Discharges were measured at two sections, one at Red River Landing and the other about one-half mile above that, about 500 feet above the store at Torras Landing.

The velocity and sounding stations were coincident, except that near the shores some extra soundings were sometimes taken.

At Red River Landing section the velocity stations were located from range signals on either shore; the distance between the velocity stations varied from 60 to 230 feet, the stations being nearest together in the deepest part of the river, and the end stations being generally from 40 to 100 feet from the bank.

At Torras Landing the distance between velocity stations was from 100 to 250 feet, but stations mainly were 200 feet apart. The end stations were 40 to 100 feet from the banks. The stations on this section were located from range signals on left bank.

For float observations, which were made on two days at Torras Landing, a range parallel to and 150 feet below section was laid out, and floats crossing discharge section at the regular velocity stations and timed between the ranges gave velocity at each station. On June 29 one set of floats was run at surface and one set at eight-tenths depth; each set was reduced to mean of vertical and results tabulated. On July 1 the discharge obtained by floats at mid-depth are given as observed, and also as reduced by vertical factor.

The Price meter No. 23, was used throughout for the two sections on the Mississippi and also for the two sections near Simmsport. The meter was generally run at each velocity station for two minutes; and at mid-depth, with a few exceptions, when the depth was three-tenths or four-tenths for several stations. All these have been reduced to mean of vertical by the following factors:

Surface	0.9753
.2 depth	0.9005
.3 depth	0.9198
.4 depth	0.9230
.5 depth	0.9572
.8 depth	1.0998

The meter was rated May 22 and July 12 and the results combined, taking the weighted mean for each meter constant; these values are given in the table of meter ratings herewith.

The bank discharge tabulated was measured on the right bank between river and

levee on days marked in table and interpolated for other days. The end of section on right bank was taken at station 0, and all on the land side of that tabulated as over-bank discharge.

The U. S. engineer gauge readings at Red River Landing, as reported by the discharge party, are tabulated; the zero of this gauge is 23.85 feet above the Cairo datum plane. Datum line is taken at 47.72 and 47.73 feet, respectively, for Red River Landing and Torras Landing sections, for computing datum areas. These readings were observed June 27 and 26, respectively. Mr. A. F. Woolley, jr., was chief of party.

SIMMSPORT, LA., ATCHAFALAYA RIVER.

These observations were taken in connection with those at Red River Landing and by the same party and instruments.

Two sections were used. One was at Simmsport, established and first used in 1892, below Bayou des Glaises and above mouth of Alligator Bayou.

The other section is stated to be about three-fourths of a mile below Simmsport.

The velocity and sounding stations were coincident and were from 60 to 100 feet apart. End velocity stations on shallow side were about 130 feet from shore, and on the deep side about 80 feet or less. The meter was run at mid-depth for two or three minutes, but generally for two minutes.

The velocity stations were located from fixed shore signals on the right bank for lower and on the left bank for upper section.

The Mississippi River Commission gauge at Barbre Landing, as read by the discharge party, is tabulated; zero of this gauge is reported to be 24.17 feet above the Cairo datum plane. Barbre Landing is about 4 miles above Simmsport. Datum line was taken on this gauge at 48.10 feet, as observed June 21, p. m., for computing datum areas of upper section, and 48.03 feet for datum areas of lower section. the latter reading observed June 21, a. m.

LITTLE ROCK, ARK., ARKANSAS RIVER, AND CLARENDON, ARK., WHITE RIVER.

Field reports upon discharge observations, 1893, at these stations appear on pages 2818 and 2819, respectively. Other notes are given on tabulation.

The results of observations at Clarendon, Ark., made in 1879 and 1892, are given in the appendix, together with some observations at other stations, made 1879, and not previously published.

Results of discharge observations, Mississippi River.

COLUMBUS, KY.

[Datum line taken at 43.81′ on the Belmont gauge, as observed May 9. Double floats; lower one at mid-depth.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Belmont.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
Feb. 20	36.30	.....	+1.3	175,848	199,148	57.1	63.4	90	3,079	.....	.....	.....	.....	.....	.....	24	XII—Strong.
22	38.50	.....	+.9	176,912	193,408	57.3	61.6	84	3,086	—5,740	7.003	1,238,984	.....	.....	22	28	XI to VI—Light.
23	39.10	.....	+.7	182,343	196,985	59	62.7	90	3,090	+3,577	7.037	1,283,218	.....	.....	18	29	VI, VIII—Strong.
24	39.70	.....	+.5	189,891	202,677	61.4	64.5	85	3,094	+5,692	7.012	1,331,419	.....	.....	19	30	XII—Light.
25	40.10	.....	+.4	193,482	205,040	62.4	65.3	84	3,103	+2,363	6.909	1,336,678	.....	.....	23	32	IX—Light to calm.
27	40.50	.....	+.2	195,462	205,786	62.8	65.4	84	3,111	+746	6.967	1,361,748	.....	.....	22	38	IX—Light.
28	40.73	.....	+.2	194,521	204,142	62.3	65	81.6	3,123	—1,644	6.929	1,347,812	.....	.....	21	28	IX-XI—Light.
Mar. 1	40.73	.....	.0	193,840	203,461	62.1	64.7	81	3,123	—681	6.812	1,320,492	.....	.....	20	26	Calm.
2	40.40	.....	—.3	193,976	204,609	62.4	65.1	81	3,109	+1,148	6.606	1,281,410	.....	.....	21	21	XI—Light.
6	33.60	.....	—2.7	167,739	199,369	54.6	63.5	71	3,071	—5,240	5.102	855,812	.....	.....	21	20	Calm.
May 5	43.13	.....	+.4	203,160	205,296	64.7	65.4	87	3,141	+5,927	7.112	1,444,773	.....	.....	20	25	V-VII—Light to brisk.
6	43.48	.....	—.4	*203,348	204,385	64.7	65.1	.....	3,141	—911	7.295	1,483,530	.....	.....	19	.....	X-XII—Light.
7	43.64	.....	—.2	207,493	208,027	66.1	66.2	86	3,141	+3,642	7.262	1,506,732	.....	.....	21	23	XII to II—Moderate.
8	43.79	.....	—.1	208,141	208,204	66.3	66.3	90	3,141	+177	7.202	1,498,986	.....	.....	20	22	I-III—Moderate.
9	43.81	.....	.0	206,718	206,718	65.8	65.8	90	3,141	—1,486	7.391	1,527,816	.....	.....	20	29	X-XII—Light.
10	43.80	.....	.0	204,720	204,751	65.2	65.2	91	3,141	—1,967	7.005	1,434,013	.....	.....	21	25	II-VIII—Light.
11	43.77	.....	.0	204,470	204,596	65.1	65.1	92	3,141	—155	7.191	1,470,346	.....	.....	21	33	IV-VI—Light to brisk.
12	43.78	.....	.0	205,715	205,809	65.5	65.5	91	3,141	+1,213	7.413	1,525,015	.....	.....	21	29	VI-VII—Light.
13	43.75	.....	.0	206,567	206,755	65.8	65.8	90	3,141	+946	7.372	1,522,724	.....	.....	21	31	VII—Mild to calm.
15	43.66	.....	—.1	207,108	207,578	65.9	66.1	92	3,141	+823	7.108	1,472,064	.....	.....	21	29	XI-II—Light.
16	43.40	.....	—.1	207,060	208,348	65.9	66.3	90	3,141	+770	6.905	1,429,744	.....	.....	21	25	IX-XI—Light.
17	42.95	.....	—.5	201,559	204,241	64.6	65	89	3,119	—4,107	6.959	1,402,701	.....	.....	21	25	VI-IX—Light.
18	42.25	.....	—.6	201,965	206,840	64.8	65.9	87	3,116	+2,599	6.578	1,328,616	.....	.....	19	31	IX—Light to calm.
19	41.63	.....	—.8	199,217	206,025	63.9	65.5	92	3,116	—815	6.673	1,329,406	.....	.....	20	35	V-VI—Light to brisk.
20	40.60	.....	—1.0	193,468	203,480	62.2	65.2	90	3,111	—6,070	5.911	1,143,556	.....	.....	20	27	VI—Light.

*Only about one-half the section sounded; balance interpolated from the 5th and 7th.

Results of discharge observations, Mississippi River—Continued.

NEW MADRID, MO., AND FULTON, TENN.

[The gauge readings are as observed by the discharge party on the Mississippi River Commission gauge at New Madrid. The water surface of May 10 at section was taken as datum line; the New Madrid gauge reading 38.10 feet. All float observations are marked "f" in table; these were with double floats, the lower float being at mid-depth. Discharges observed with meter (except those marked f), meter at six-tenths depth.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	New Madrid.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
Feb. 20	31	.....	+1.3	214,638	259,091	34.5	41.1	53	6,215	.....	5.454	1,170,742	.....	.....	26	84	II.
21	31.85	.....	+.9	221,993	261,130	35.7	41.4	54	6,216	+2,039	5.054	1,121,940	.....	.....	24	67	XI—Medium.
22	32.66	.....	+.7	224,010	258,075	36	40.9	54	6,218	−3,055	5.287	1,184,234	.....	.....	26	73	
23	33.10	.....	+.6	226,349	257,709	36.3	40.9	54.5	6,236	−266	5.186	1,173,934	.....	.....	27	81	VII—Strong.
24	33.60	.....	+.6	231,725	259,958	37.1	41.2	55	6,241	+2,249	5.378	1,246,317	.....	.....	29	93	VIII—Slight.
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.057	f1,171,807	.....	.....	25	.....	
25	33.97	.....	+.4	239,054	264,976	38.3	42	55	6,246	+5,018	5.233	1,250,956	.....	.....	27	77	VII—Slight.
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.230	f1,250,147	.....	.....	25	.....	
27	34.55	.....	+.2	233,538	255,825	37.4	40.6	57	6,248	−9,151	5.459	1,274,866	.....	.....	27	74	V—Medium.
28	34.73	.....	+.2	239,338	260,495	38.3	41.3	55.8	6,248	+4,670	5.401	1,292,621	.....	.....	26	75	X—Slight.
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.107	f1,222,256	.....	.....	25	.....	
Mar. 1	34.88	.....	+.2	242,483	262,702	38.8	41.7	58	6,251	+2,207	6.537	*1,585,155	.....	.....	26	90	IX—Slight.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.263	f1,276,088	.....	.....	24	.....	
2	34.91	.....	.0	242,944	262,977	38.8	41.7	55	6,254	+275	5.282	1,283,242	.....	.....	26	93	Calm.
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f4.856	f1,179,771	.....	.....	25	.....	
3	34.70	.....	−.2	†242,500	.....	38.8	.....	.....	6,254	.....	5.132	1,244,413	.....	.....	28	.....	I—Medium.
5	33	.....	−1	233,550	265,568	37.4	42.1	53.5	6,248	+2,591	5.237	1,223,146	.....	.....	26	95	Calm.
6	30.90	.....	−2.1	219,014	264,180	35.1	41.9	52	6,239	−1,388	4.885	1,069,964	.....	.....	26	104	VI—Slight.
7	28.51	.....	−2.7	202,766	262,866	32.6	41.7	49	6,228	−1,314	4.788	970,854	.....	.....	26	105	Calm.
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f4.477	f907,717	.....	.....	25	.....	
May 4	36	.....	+.5	247,466	260,696	39.3	41.3	49.5	6,296	−2,170	5.143	1,272,692	.....	.....	23	100	IX—Slight.
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.108	f1,264,070	.....	.....	23	.....	
5	36.53	.....	+.5	253,912	263,808	40.3	41.8	52	6,299	+3,112	5.413	1,374,385	.....	.....	27	100	VII—Slight.
6	37.03	.....	+.5	252,850	259,595	40.1	41.2	50	6,302	−4,213	5.689	1,438,494	.....	.....	25	108	XII.
8	37.87	.....	+.3	268,509	269,959	42.6	42.8	54	6,305	+10,364	5.724	1,536,967	.....	.....	27	122	III—Mild.
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.414	f1,453,823	.....	.....	25	.....	
9	38.06	.....	+.2	262,803	263,055	41.7	41.7	51.8	6,306	−6,904	5.639	1,481,924	.....	.....	28	100	II—Slight.
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.525	f1,452,030	.....	.....	25	.....	
10	38.10	.....	.0	264,392	264,392	41.9	41.9	52	6,307	+1,387	5.529	1,461,737	.....	.....	28	120	II—Mild.
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.492	f1,452,080	.....	.....	26	.....	
11	38.08	.....	.0	258,815	258,941	41	41.1	54.4	6,306	−5,451	5.891	1,524,703	.....	.....	27	111	V—Medium.
12	38.04	.....	.0	259,960	260,338	41.2	41.3	54.8	6,306	+1,397	5.386	1,400,083	.....	.....	27	159	Calm.
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.620	f1,461,055	.....	.....	25	.....	

13	37.98	.....	—.1	263,627	264,384	41.8	41.9	54.4	6,307	+4,046	5.662	1,492,632	.....	.....	29	158	IX—Slight.
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.568	f1,467,885	.....	.....	25	.....	
15	37.94	.....	.0	260,100	261,109	41.2	41.4	54.4	6,308	—3,275	5.838	1,518,353	.....	.....	29	145	II—Slight.
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.611	f1,459,355	.....	.....	25	.....	
16	37.76	.....	—.2	256,965	259,110	40.7	41.1	54.5	6,308	—1,999	5.753	1,478,412	.....	.....	28	140	II—Strong.
17	37.50	.....	—.3	252,406	256,190	40	40.6	53.6	6,307	—2,920	5.720	1,443,705	.....	.....	26	147	XII—Slight.
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f5.447	f1,374,870	.....	.....	25	.....	
18	37.06	.....	—.4	251,119	257,677	39.8	40.9	53	6,304	+1,487	5.480	1,376,118	.....	.....	26	161	Calm.
19	36.49	.....	—.6	246,729	256,882	39.1	40.7	54	6,304	+1,205	5.414	1,335,668	.....	.....	26	140	VII—Strong.
20	35.90	.....	—.7	236,972	250,841	37.6	39.8	52.7	6,300	—8,041	5.282	1,251,801	.....	.....	26	153	Calm.

* Observer considers velocities too high, and says to reject this discharge.

† Area interpolated from 2d and 5th.

FULTON, TENN.

[Datum line at 34.58′ on the Mississippi River Commission gauge at Fulton as observed May 16. All velocities measured with double floats; lower float at mid-depth.]

Feb.	24	*29.95	.....	+0.6	153,738	168,934	47	51.2	70	3,268	.....	6.310	970,128	.....	.....	19	41	V—Very light.
	25	30.48	.....	+.5	152,407	165,863	46.6	50.3	66.6	3,268	—5,227	6.898	1,051,292	.....	.....	20	29	II—Light.
	28	31.45	.....	+.3	153,657	163,942	46.9	49.7	71.1	3,276	+235	6.909	1,061,840	.....	.....	20	41	X—Light.
Mar.	1	31.68	.....	+.2	157,346	166,881	48	50.6	69.3	3,278	+2,639	7.187	1,130,847	.....	.....	20	41	I—Very light.
	2	31.87	.....	+.2	160,807	169,717	49.1	51.5	74.5	3,278	+2,836	6.822	1,097,096	.....	.....	20	33	II to V—Light.
	3	32.03	.....	+.2	163,363	171,753	49.8	52.1	73.8	3,282	+2,036	.....	.....	.....	.....	.....	37	I—Light.
	4	32.21	.....	+.2	163,631	171,428	49.8	52	75	3,284	—325	7.433	1,216,299	.....	.....	20	31	IX—Strong.
	6	31.85	.....	—.3	160,935	169,917	49	51.5	75	3,284	—1,511	6.761	1,088,131	.....	.....	19	25	V—Light.
	7	31.08	.....	—.8	158,463	169,957	48.4	51.5	73.8	3,272	+40	6.672	1,057,339	.....	.....	22	37	V—Light.
May	5	32.80	.....	+.3	163,078	168,747	49.5	51.2	73.3	3,295	—1,210	6.865	1,119,609	.....	.....	19	32	V—Strong.
	8	33.87	.....	+.4	166,665	169,005	50.6	51.3	75.6	3,296	+258	7.352	1,225,245	.....	.....	15	35	Calm.
	10	34.37	.....	+.2	†190,623	191,315	57.8	58	79.5	3,296	+22,310	7.030	1,340,137	.....	.....	20	38	Calm.
	11	34.47	.....	+.1	175,819	176,182	53.3	53.4	73.8	3,296	—15,133	7.188	1,263,791	.....	.....	20	36	IV—Strong.
	13	34.57	.....	.0	172,515	172,548	52.3	52.3	75.6	3,296	—3,634	7.364	1,270,351	.....	.....	20	38	VII to IX—Light.
	16	34.58	.....	.0	175,126	175,126	53.1	53.1	76.7	3,297	+2,578	6.897	1,207,891	.....	.....	20	35	X—Light.
	17	34.55	.....	.0	177,423	177,522	53.8	53.8	76.1	3,297	+2,396	7.109	1,262,270	.....	.....	20	36	X—Light.
	19	34.40	.....	—.1	171,884	172,477	52.1	52.3	72.2	3,297	—5,045	6.735	1,157,635	.....	.....	20	34	V—Moderate.
	23	33.11	.....	—.6	166,387	171,234	50.5	51.9	71.1	3,297	—1,243	6.601	1,098,299	.....	.....	20	38	IX—Moderate.

* Fulton gauge.

† See field report.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.

[Discharges observed with meter (except those marked f), meter at six-tenths depth. All float observations are marked "f" in table; double floats were used, the lower float being at mid-depth. When meter and floats were used on same day, one set of soundings answered for both. Datum line taken at 47.90′ on the Helena gauge as observed May 25.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Helena.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.			Per second.	Over bank per second.				
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
May 9	43.14	.....	+0.2	191,026	214,778	38.3	43	86.6	4,982	.....	6.191	1,182,682	7,200	1,189,882	19	35	Calm.
10	43.34	.....	+.2	193,915	216,669	38.9	43.3	87.2	4,982	+1,891	6.199	1,201,999	*7,700	1,209,699	20	41	Do.
11	43.49	.....	+.2	190,470	212,480	38.2	42.5	83.6	4,983	—4,189	6.244	1,189,330	7,900	1,197,230	20	36	III—Moderate.
12	43.70	.....	+.2	197,960	218,922	39.7	43.8	90	4,983	+6,442	f6.167	f1,220,835	8,200	1,229,035	17	44	X—Brisk.
13	43.81	.....	+.2	202,742	223,155	40.7	44.6	90.4	4,983	+4,233	f6.191	f1,255,220	8,400	1,263,620	17	43	VII to IX—Light.
15	44.20	.....	+.3	205,199	223,666	41.2	44.7	91.3	4,983	+511	6.237	1,279,883	8,900	1,288,783	20	62	IX to XII—Light.
15											f6.316	f1,296,020	8,900	1,304,920	20	.....	XII—Light.
16	44.40	.....	+.2	212,448	229,916	42.6	46	94.6	4,983	+6,250	6.459	1,372,305	9,200	1,381,505	20	73	XII—Brisk.
16											f6.145	f1,305,580	9,200	1,314,780	19	.....	XII—Light.
17	44.60	.....	+.2	206,055	222,529	41.3	44.5	91	4,984	—7,387	6.257	1,289,374	9,500	1,298,874	20	56	IX—Light.
17											f6.093	f1,255,640	9,500	1,265,140	20	.....	IX—Strong.
18	44.89	.....	+.2	211,505	226,531	42.4	45.3	91.8	4,984	+4,002	6.354	1,343,996	9,900	1,353,896	20	74	Calm.
19	45.22	.....	+.4	206,197	219,576	41.3	43.9	89.1	4,985	—6,955	6.462	1,332,472	10,300	1,342,772	20	63	IV—Brisk.
19											f6.316	f1,302,255	10,300	1,312,555	20	.....	IX—Brisk.
20	45.72	.....	+.5	213,495	224,382	42.8	44.9	92.7	4,988	+4,806	6.604	1,409,875	11,000	1,420,875	20	61	III—Light.
22	46.89	.....	+.5	227,351	232,397	45.5	46.5	95.6	4,994	+8,015	f6.374	f1,449,090	*12,700	1,461,790	21	52	VI—Strong.
23	47.48	.....	+.5	231,219	233,318	46.3	46.7	96.8	4,995	+921	6.834	1,580,240	13,500	1,593,740	20	68	IX—Strong.
23											f6.672	f1,542,640	13,500	1,556,140	21	.....	
24	47.73	.....	+.3	218,291	219,141	43.7	43.8	93.8	4,999	—14,177	6.813	1,487,321	13,800	1,501,121	22	97	III—Strong.
24											f6.907	f1,507,715	13,800	1,511,515	22	.....	
25	47.90	.....	+.1	223,379	223,379	44.7	44.7	94	4,999	+4,238	6.896	1,540,419	14,100	1,554,519	21	100	Calm.
25											f6.985	f1,560,310	14,100	1,574,410	21	.....	
26	47.80	.....	—.1	220,659	221,109	44.1	44.2	94	4,999	—2,270	6.857	1,512,962	13,900	1,526,862	21	105	VII—Strong.
26											f6.831	f1,507,230	13,900	1,521,130	20	.....	
29	47.00	.....	—.5	217,802	222,300	43.6	44.5	92	4,998	+1,191	6.595	1,436,510	12,800	1,449,310	21	114	VI—Medium strong.
29											f6.669	f1,452,605	12,800	1,465,405	21	.....	
31	45.90	.....	—.5	210,791	220,785	42.2	44.2	.....	4,995	—1,515	6.516	1,373,442	11,300	1,384,742	21	‡107	V—Medium strong.
June 1	45.85	.....	.0	211,227	221,469	42.3	44.3	91.5	4,992	+684	6.638	1,402,076	11,200	1,413,276	21	127	X—Slight.
1											f6.511	f1,375,347	11,200	1,386,547	21	.....	VII.
2	45.71	.....	—.2	†210.058	.....	42.1	44.2	.....	4,992	.....	6.545	1,374,913	11,000	1,385,913	§21	.....	Calm.
5	45.30	.....	—.1	206.554	219,538	41.4	43.9	91	4,990	—1,931	6.455	1,333,242	10,500	1,343,742	20	140	XI—Slight.

* Observed; floats used. † Area interpolated from June 1 and 5. ‡ Sixty-seven of these from May 29, corrected for stage. § Three of these from June 1.

ARKANSAS CITY, ARK.

[Discharges herein tabulated, observed at different proportional depths, are all reduced to mean of vertical, unless otherwise noted. Datum line at 49.81′ as observed at section May 29; the Arkansas City reading 50.3′ at same time.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.			Width.			Per second.	Over bank per second.				
	Arkansas City.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
Mar. 9	43.1	42.88	+0.2	222,030	245,925	64.5	71.2	95.5	3,441	.....	*4.747	*1,054,011	.....	.....	22	56	V—Light.
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	†4.829	†1,072,097	.....	.....	22	.....	.....
10	43.2	43.01	+.1	218,220	241,666	63.4	69.9	95.5	3,441	—4,259	*4.747	*1,035,842	.....	.....	22	46	III—Light.
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	†4.828	†1,053,617	.....	.....	22	.....	.....
11	43.2	42.98	.0	224,662	248,212	65.3	71.8	96	3,441	+6,546	*4.491	*1,008,947	.....	.....	23	57	VII-IX—Brisk.
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	†4.568	†1,026,260	.....	.....	23	.....	.....
13	43	42.76	—.2	221,692	246,000	64.4	71.2	96.5	3,441	—2,212	4.989	1,106,114	.....	.....	23	55	V—Light to brisk.
18	40.7	40.46	—.4	212,662	244,882	61.9	70.9	91.5	3,436	—1,118	4.735	1,007,044	.....	.....	23	50	X—Brisk.
20	40.2	39.98	—.2	201,750	235,605	58.8	68.2	92.5	3,434	—9,277	4.615	931,144	.....	.....	23	49	III—Light.
21	40	39.78	—.2	204,308	238,851	59.5	69.1	95.5	3,433	+3,246	4.700	960,242	.....	.....	23	59	Calm.
22	39.9	39.71	—.1	206,408	241,182	60.2	69.8	92	3,431	+2,331	4.764	983,340	.....	.....	23	51	IV—Light.
24	39.9	39.71	.0	205,290	240,064	59.8	69.5	89.5	3,431	—1,118	4.576	939,398	.....	.....	23	51	VIII—Light.
25	40	39.78	+.1	205,335	239,858	59.9	69.4	92	3,429	—206	4.609	946,303	.....	.....	23	48	XII—Light.
27	40	39.81	.0	200,835	235,255	58.6	68.1	90	3,429	—4,603	4.634	930,647	.....	.....	23	52	Do.
29	39.9	39.71	—.1	200,550	235,313	58.5	68.1	92	3,429	+58	4.545	911,489	.....	.....	23	50	VII—Light.
‡29	39.9	.....	.....	205,260	.....	46.2	.....	70	4,440	.....	4.489	921,404	.....	.....	23	61	.....
‡30	39.6	.....	.....	203,018	.....	45.8	.....	69	4,437	.....	4.573	928,468	.....	.....	23	53	.....
30	39.6	39.51	—.2	202,388	237,820	59.1	68.8	91	3,425	+2,507	4.586	928,197	.....	.....	23	50	V—Light.
31	39.4	39.06	—.3	205,598	242,578	60	70.2	90	3,424	+4,758	4.410	906,626	.....	.....	22	52	IV—High.
Apr. 1	39	38.78	—.4	198,615	236,547	58	68.5	89	3,423	—6,031	4.345	862,977	.....	.....	23	53	IV—Light to brisk.
3	38	37.65	—.6	195,375	237,181	57.1	68.6	86.5	3,421	+634	4.279	836,023	.....	.....	23	50	Do.
4	37.4	37.08	—.6	192,120	235,860	56.2	68.3	84.5	3,418	—1,321	4.274	821,038	.....	.....	13	54	VI—Light.
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f 4.269	f 820,109	.....	.....	23	.....	.....
5	36.6	36.35	—.8	193,275	239,523	56.5	69.3	85	3,418	+3,663	4.092	790,964	.....	.....	23	56	IV—Light.
6	35.8	35.58	—.7	186,832	235,698	54.8	68.2	84	3,412	—3,825	4.085	763,296	.....	.....	23	48	Do.
7	35	34.82	—.8	181,822	233,253	53.4	67.5	83	3,407	—2,445	4.056	737,527	.....	.....	23	52	IV—High.
8	34.2	34.08	—.8	179,678	233,616	52.8	67.6	81.5	3,403	+363	§3.960	§711,462	.....	.....	.....	54	Do.
May 5	46.2	45.93	+.6	230,685	244,090	66.8	70.6	96.5	3,455	+10,474	5.183	1,195,548	2,782	1,198,330	21	45	IX—Brisk.
6	46.8	46.56	+.6	238,920	250,149	69.2	72.4	99	3,455	+6,059	5.187	1,239,328	3,184	1,242,512	23	53	XI—Light.
8	48.1	47.74	+.5	246,285	253,437	71.3	73.4	101.5	3,455	+3,288	5.373	1,323,389	‖5,535	1,328,924	23	55	XII—Light.

* Observed at six-tenths depth and reduced by vertical factor. † As observed at six-tenths depth. ‡ Upper section. f Float observations. § Flanking results, as no stationary observations were taken this day. ‖ Bank discharge observed.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

[Discharges herein tabulated, observed at different proportional depths, are all reduced to mean of vertical, unless otherwise noted. Datum line at 49.81′ as observed at section May 29; the Arkansas City reading 50.3′ at same time.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Arkansas City.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
May 9	48.4	48.14	+.4	249,202	254,972	72.1	73.8	102	3,455	+1,535	5.485	1,366,877	5,622	1,372,499	23	54	X—Light.
10	48.8	48.40	+.3	249,630	254,502	72.3	73.7	102.5	3,455	—470	5.505	1,374,195	5,709	1,379,904	23	52	VI—Light.
11	49	48.54	+.2	252,555	256,943	73.1	74.4	104	3,455	+2,441	5.543	1,400,015	5,796	1,405,811	23	52	Do.
12	49.1	48.71	+.2	251,625	255,425	72.8	73.9	104.5	3,455	—1,518	5.569	1,401,375	*5,880	1,407,255	23	53	XII—Light.
13	49.2	48.84	+.1	257,558	260,909	74.5	75.5	104.5	3,455	+5,484	5.520	1,421,688	6,423	1,428,111	23	53	V—Pleasant.
15	49.6	49.12	+.2	256,958	259,342	74.4	75.1	103	3,455	—1,567	5.626	1,445,746	6,929	1,452,675	23	51	X—Pleasant.
16	49.6	49.24	.0	254,325	256,294	73.6	74.2	102	3,455	—3,048	5.587	1,420,832	7,455	1,428,287	23	54	X—Brisk.
17	49.6	49.25	.0	250,282	252,217	72.4	73	104	3,455	—4,077	5.605	1,402,932	7,979	1,410,911	23	52	XII—Pleasant.
18	49.6	49.26	.0	254,025	255,925	73.5	74.1	105.5	3,455	+?,708	5.679	1,442,537	*8,112	1,450,649	23	50	IV—Pleasant.
19	49.6	49.26	.0	255,420	257,320	73.9	74.5	102.5	3,455	+1,395	†5.599	†1,430,086	8,095	1,438,181	23	52	V—Pleasant.
19											‡5.695	‡1,454,626	8,095	1,462,721			
20	49.6	49.23	.0	254,858	256,862	73.8	74.3	104.5	3,455	—458	5.625	1,433,480	8,095	1,441,575	23	52	V—Pleasant.
22	49.6	49.26	.0	248,242	250,142	71.9	72.4	103	3,455	—6,720	5.641	1,400,246	8,261	1,408,507	23	51	VI—Brisk.
23	49.7	49.28	+.1	252,878	254,709	73.2	73.7	102	3,455	+4,567	5.638	1,425,787	8,305	1,434,092	23	52	VII-X—High.
24	49.8	49.44	+.2	258,360	259,638	74.8	75.1	102	3,455	+4,929	5.663	1,463,012	8,350	1,471,362	23	53	V-I—Light.
24											‡5.543	‡1,432,009	8,350	1,440,359			
24											†5.449	†1,407,851	8,350	1,416,201			
25	50	49.53	+.1	255,870	256,837	74.1	74.3	102	3,455	—2,801	5.595	1,431,590	8,433	1,440,023	23	53	XII—Light.
26	50	49.58	.0	260,768	261,563	75.5	75.7	104	3,455	+4,726	5.399	1,407,988	*8,520	1,416,508	23	53	V—Pleasant.
27	50	49.64	.0	260,992	261,579	75.5	75.7	104	3,455	+16	6.388	1,667,306	8,808	1,676,114	23	51	Do.
29	50.2	49.81	.0	259,192	259,192	75	75	103.5	3,455	—2,387	5.897	1,528,432	9,106	1,537,538	23	52	I-X—Pleasant.
31	49.8	49.44	—.2	258,480	259,758	74.8	75.2	104	3,455	+566	5.786	1,495,611	8,412	1,504,023	23	51	V—High.
June 1	49.6	49.32	—.2	256,950	258,643	74.4	74.9	103	3,455	—1,115	5.818	1,494,892	8,112	1,503,004	23	52	VII—Pleasant.
2	49.6	49.11	.0	259,590	262,008	75.1	76.1	105.5	3,455	+3,365	5.734	1,488,620	7,829	1,496,449	23	52	I—Light.
3	49.6	49.20	.0	259,118	261,226	75	75.6	104.5	3,455	—782	5.695	1,475,746	7,583	1,483,329	23	51	II—Pleasant.
5	49.6	49.20	.0	257,888	259,996	74.6	75.2	104	3,455	—1,230	5.668	1,461,733	7,437	1,469,170	23	52	XI—Light.
7	49.5	49.21	—.1	256,680	258,753	74.3	74.9	103.5	3,455	—1,243	5.632	1,445,528	7,090	1,452,618	23	52	XII—Pleasant.

NOTE.—See pp. 2831 and 2832 for "flanking" results.

* Bank discharge observed. † Observed at six-tenths depth and reduced by vertical factor. ‡ As observed at six-tenths depth.

[Results by different methods of observing velocities with the current meter. Mean velocity is given in feet per second. Discharge is cubic feet per second. The column of "Difference" gives resulting difference between the two methods, "flanking" mean and "stationary." Bank discharge is not included in this table.]

Date.	Gauges.			Flanking method.						Stationary method.		Difference in discharge.	Remarks.
		Section.		Arkansas to Mississippi.		Mississippi to Arkansas.		Mean					
	Arkansas City.	Arkansas.	Mississippi.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Mean velocity.	Discharge.		
1893.	*Feet.*	*Feet.*	*Feet.*										
Mar. 9	43.1	43.08	42.69							4.747	1,054,011		
10	43.2	43.18	42.84							4.747	1,035,842		
11	43.2	43.18	42.79							4.491	1,008,947		
13	43	42.88	42.64							4.989	1,106,114		
18	40.7	40.58	40.34							4.735	1,007,044		
20	40.2	40.08	39.89							4.615	981,144		
21	40	39.93	39.64	4.692	958,682	4.461	911,409	4.577	935,046	4.700	960,242	−25,196	
22	39.9	39.83	39.59							4.764	983,340		
24	39.9	39.83	39.59							4.576	939,398		
25	40	39.88	39.67	4.530	930,066	4.397	902,916	4.463	916,491	4.609	946,303	−29,812	
27	40	39.88	39.74	4.648	933,574	4.636	931,040	4.642	932,307	4.634	930,647	+1,660	
29	39.9	39.83	39.59							4.545	911,489		
30	39.6	39.63	39.39							4.586	928,197		
31	39.4	39.13	38.99							4.410	906,626		
Apr. 1	39	38.95	38.62	4.443	882,546	4.274	848,862	4.359	865,704	4.345	862,977	+2,727	
3	38	37.73	37.57	4.285	837,170	4.178	816,374	4.232	826,772	4.279	836,023	−9,251	
4	37.4	37.18	36.99	4.266	819,530	4.209	808,544	4.237	814,037	4.274	821,038	−7,001	Double floats give mean velocity, 4.269; discharge, 820,109.
5	36.6	36.41	36.29	4.238	819,038	4.135	799,160	4.186	809,099	4.092	790,964	+18,135	
6	35.8	35.63	35.54	4.100	766,075	4.014	750,040	4.057	758,058	4.085	763,296	−5,238	
7	35	34.86	34.79	4.073	740,536	3.861	702,072	3.967	721,304	4.056	737,527	−16,223	
8	34.2	34.13	34.04	3.985	715,940	3.935	706,983	3.960	711,462				
May 5	46.2	45.93								5.183	1,195,548		
6	46.8	46.78	46.34							5.187	1,229,328		
8	48.1	47.98	47.49	5.454	1,343,252	5.324	1,311,170	5.389	1,327,211	5.373	1,323,389	+3,822	
9	48.4	48.41	47.87	5.395	1,344,453	5.433	1,353,789	5.414	1,349,121	5.485	1,366,877	−17,756	
10	48.8	48.66	48.13	5.535	1,381,741	5.508	1,374,862	5.521	1,378,302	5.505	1,374,195	+4,107	
11	49	48.83	48.24	5.600	1,414,254	5.409	1,366,092	5.504	1,390,173	5.543	1,400,015	−9,842	River full of boils.
12	49.1	48.98	48.44	5.573	1,402,311	5.558	1,398,642	5.566	1,400,476	5.569	1,401,375	−899	Do.
13	49.2	49.09	48.59	5.407	1,392,705	5.529	1,424,022	5.468	1,408,364	5.520	1,421,688	−13,324	River full of boils and drift.
15	49.6	49.38	48.87	5.494	1,411,642	5.530	1,420,906	5.512	1,416,274	5.626	1,445,746	−29,472	
16	49.6	49.50	48.97							5.587	1,420,832		
17	49.6	49.51	48.99	5.478	1,370,976	5.583	1,397,412	5.530	1,384,194	5.605	1,402,932	−18,738	River full of boils.
18	49.6	49.53	48.99	5.551	1,410,004	5.700	1,447,927	5.625	1,428,966	5.679	1,442,537	−13,571	
19	49.3	49.52	49.01	5.749	1,468,369	5.778	1,475,738	5.763	1,472,054	5.599	1,430,086	+41,968	
20	49.6	49.50	48.96	5.619	1,431,934	5.571	1,419,850	5.595	1,425,892	5.625	1,433,480	−7,588	
22	49.6	49.55	48.96	6.318	1,568,462	5.626	1,396,509	5.972	1,482,486	5.641	1,400,246	+82,240	
23	49.7	49.58	48.99	5.635	1,424,878	5.607	1,417,816	5.621	1,421,347	5.638	1,425,787	−4,440	

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

[Results by different methods of observing velocities with the current meter. Mean velocity is given in feet per second. Discharge is cubic feet per second. The column of "Difference" gives resulting difference between the two methods, "flanking" mean and "stationary." Bank discharge is not included in this table.]

Date.	Gauges.			Flanking method.						Stationary method.		Difference in discharge.	Remarks.
		Section.		Arkansas to Mississippi.		Mississippi to Arkansas.		Mean.					
	Arkansas City.	Arkansas.	Mississippi.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Mean velocity.	Discharge.		
1893.	*Feet.*	*Feet.*	*Feet.*										
May 24	49.8	49.69	49.19							5.663	1,463,012		
24										5.449	1,407,851		
25	50	49.81	49.25	5.746	1,470,188	5.630	1,440,488	5.688	1,455,338	5.595	1,431,590	+23,748	
26	50	49.83	49.34	5.668	1,478,123	5.726	1,493,258	5.697	1,485,690	5.399	1,407,988	+77,702	
27	50	49.93	49.34	6.103	1,592,842	5.898	1,539,266	6.000	1,566,054	6.388	1,667,306	−101,252	
29	50.2	50.08	49.54	5.937	1,538,755	5.960	1,544,849	5.948	1,541,802	5.807	1,528,432	+13,370	Cypress Cr. crevasse occurred at 4 a. m.
31	49.8	49.73	49.14							5.786	1,495,611		
June 1	49.6	49.61	49.04	5.720	1,469,670	5.706	1,466,174	5.713	1,467,922	5.818	1,494,892	−26,970	
2	49.6	49.38	48.84	5.837	1,515,138	5.785	1,501,653	5.811	1,508,396	5.734	1,488,620	+19,776	
3	49.6	49.48	48.91	5.713	1,480,275	5.754	1,491,010	5.733	1,485,642	5.695	1,475,746	+9,896	
5	49.6	49.45	48.94	5.747	1,482,134	5.728	1,477,139	5.738	1,479,637	5.668	1,461,733	+17,904	
7	49.5	49.43	48.99	5.643	1,448,408	5.524	1,417,888	5.583	1,433,148	5.632	1,445,528	−12,380	

NOTE.—See pp. 2829 and 2830 for areas; areas are the same for all methods.

WILSON POINT, LA.

[Discharges herein tabulated, observed at different proportional depths, are all reduced to mean of vertical unless otherwise noted. Zero of Wilson Point gauge is 93.45 feet above the Cairo datum plane. Datum line is at 41 feet on Wilson Point gauge. These observations taken with meter by stationary method unless otherwise noted. Results of "flanking" method given on other tables. Results of float observations are marked f.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of sound ings.	Direction and force of wind.
				Area.		Depth.			Width.			Per second.	Over bank per second.				
	Lake Providence.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
Mar. 7	34.5	34.40	+0.4	189,014	214,516	49	55.4	69	3,857	.....	5.463	1,032,497	.....	.....	23	38	VIII—Fair.
9	35.2	34.84	+ .3	191,947	215,749	49.8	55.7	66.5	3,857	+1,233	5.499	1,055,404	.....	.....	23	60	VIII—Light.
10	35.4	35.06	+ .2	196,412	219,364	50.9	56.7	68	3,857	+3,615	5.445	1,069,479	.....	.....	23	55	VI—Very light.
11	35.6	35.19	+ .1	200,277	222,727	51.9	57.5	68.5	3,858	+3,363	5.317	1,064,936	.....	.....	23	57	IX—Fair.
13	35.7	35.26	.0	187,161	209,352	48.5	54.1	66	3,860	−3,375	5.428	1,015,849	.....	.....	23	56	VII—Strong.
14	35.6	35.12	− .1	195,053	217,785	50.5	56.3	67	3,860	+8,433	5.523	1,077,256	.....	.....	26	61	XI—Light.
15	35.4	34.84	− .3	194,043	217,858	50.3	56.3	66.5	3,860	+73	5.592	1,085,111	.....	.....	26	64	I—Strong.
16	35.1	34.50	− .3	194,884	220,000	50.5	56.8	67.5	3,858	+2,142	5.591	1,089,516	.....	.....	26	63	IV—Fair.
17	34.8	34.30	− .2	190,685	216,574	49.4	55.9	66	3,857	−3,426	5.480	1,044,950	.....	.....	26	60	X—Fair.
18	34.5	33.93	− .4	183,559	210,877	47.6	54.5	66	3,857	−5,697	5.589	1,025,991	.....	.....	26	62	I—Fair.
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f 5.499	f1,009,368	.....	.....	.....	.....	.....
20	34.1	33.49	− .2	186,880	215,899	48.5	55.8	67	3,856	+5,022	5.408	1,010,642	.....	.....	26	55	VIII—Fair.
21	33.9	33.29	− .2	185,565	215,356	48	55.6	66.5	3,856	−543	f 5.410	f1,003,889	.....	.....	26	62	VI—Very light.
22	33.6	33.10	− .2	180,834	211,360	46.9	54.6	66.5	3,856	−3,996	5.373	971,563	.....	.....	26	61	VI—Light.
23	33.5	32.98	− .1	180,408	211,397	46.8	54.6	65	3,856	+37	5.381	970,857	.....	.....	26	62	VI—Light.
24	33.6	32.98	.0	181,752	212,741	47.1	55	65	3,856	+1,344	5.332	969,182	.....	.....	26	61	XII—Very light.
25	33.5	32.93	.0	180,201	211,383	46.7	54.6	65	3,856	−1,358	5.299	954,821	.....	.....	26	62	II—Light.
27	33.5	32.94	.0	181,930	213,074	47.2	55	63.5	3,856	+1,691	5.179	942,281	.....	.....	26	61	I—Light.
28	33.4	32.94	.0	185,239	216,382	48	55.9	64	3,856	+3,309	5.156	955,124	.....	.....	14	59	II—Light.
30	33.3	32.77	− .1	179,826	211,627	46.6	54.7	63	3,856	−4,756	5.173	930,194	.....	.....	26	60	VII—Light.
31	33.1	32.56	− .2	185,281	217,885	48.1	56.3	62.5	3,855	+6,258	5.197	962,973	.....	.....	26	60	IX—Light.
r. 1	32.9	32.34	− .2	184,631	218,085	47.9	56.3	62.5	3,855	+200	5.023	927,470	.....	.....	26	59	VII—Light.
3	32.2	31.71	− .3	180,119	216,006	46.7	55.8	62.5	3,855	−2,079	4.918	885,829	.....	.....	26	59	VII—Fair.
4	31.8	31.32	− .4	185,995	223,389	48.2	57.7	62.5	3,855	+7,383	4.770	887,224	.....	.....	26	60	VIII—Very light.
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	f 4.718	f 877,543	.....	.....	.....	.....	.....
5	31.3	30.74	− .6	180,178	219,812	46.7	56.8	62.5	3,855	−3,577	4.701	847,094	.....	.....	26	58	VI—Light.
6	30.6	30.08	− .7	177,028	219,212	45.9	56.6	62.5	3,855	−600	4.730	837,264	.....	.....	26	57	VIII—Fair.
7	30	29.55	− .5	177,843	222,074	46.1	57.4	62	3,855	+2,862	4.648	826,638	.....	.....	26	59	VIII—Strong.
8	29.3	28.73	− .8	174,022	221,421	45 1	57.2	61	3,855	−653	4.506	784,099	.....	.....	26	62	VIII—Fair.
May 5	38	37.28	+ .6	207,875	222,275	53.7	57.4	72	3,871	+854	5.673	1,179,324	8.543	1,187,867	26	58	VII—Light.
6	38.7	37.88	+ .6	213,290	225,368	55.1	58.2	72	3,871	+3,093	5.843	1,246,150	11,419	1,257,569	26	59	XII—Light.
8	40.1	39.36	+ .6	221,110	227,458	57.1	58.8	74	3,871	+2,090	5.911	1,307,037	17,104	1,324,141	26	58	XII—Very light.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

[Discharges herein tabulated, observed at different proportional depths, are all reduced to mean of vertical unless otherwise noted. Zero of Wilson Point gauge is 93.45 feet above the Cairo datum plane. Datum line is at 41 feet on Wilson Point gauge. These observations taken with meter by stationary method unless otherwise noted. Results of "flanking" method given on other tables. Results of float observations are marked f.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Lake Providence.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
May 9	40.7	39.88	+.5	221,212	225,548	57.1	58.3	75.5	3,871	−1,910	6.141	1,358,362	*19,947	1,378,309	26	58	XII—Light.
10	41.1	40.32	+.4	222,243	224,875	57.4	58.1	74	3,871	−673	6.068	1,348,520	22,269	1,370,789	26	58	VI—Very light.
†11	41.4	40.57	+.2	227,368	229,033	58.7	59.2	74	3,871	+4,158	6.141	1,396,284	23,787	1,420,071	26	59	V—Light.
12	41.4	40.64	+.1	225,482	226,876	58.2	58.6	74	3,871	−2,157	6.134	1,383,005	25,305	1,408,310	26	61	II—Light.
13	41.5	40.74	+.1	227,250	228,257	58.7	59	75	3,871	+1,381	6.066	1,378,604	26,823	1,405,427	26	59	V—Very light.
‡§15	41.8	41	+.2	231,714	231,714	59.9	59.9	75	3,871	+3,457	5.939	1,376,219	29,859	1,406,078	26	60	XII—Very light.
16	41.3	40.99	−.1	227,296	227,335	58.7	58.7	73	3,871	−3,992	5.944	1,351,121	*31,378	1,382,499	26	58	I—Strong.
17	41.8	41	+.1	230,273	230,273	59.5	59.5	73.5	3,871	+2,551	5.847	1,346,321	31,329	1,377,650	26	58	I—Light.
18	41.8	40.97	.0	232,670	232,786	60.1	60.1	73.5	3,871	+2,513	5.842	1,359,301	31,280	1,390,581	26	58	VI—Very light.
19	41.8	40.97	.0	229,847	229,963	59.4	59.4	74	3,871	−2,823	5.947	1,366,852	31,231	1,398,083	26	58	VII—Light.
¶20	41.8	40.96	.0	231,185	231,340	59.7	59.8	74	3,871	+1,377	5.868	1,356,704	31,182	1,387,886	26	58	VI—Very light.
§22	41.8	40.96	.0	237,932	258,087	61.5	61.5	75	3,871	+6,747	5.694	1,354,766	31,080	1,385,846	26	58	VII—Brisk.
23	41.7	40.96	.0	234,908	235,153	60.7	60.7	74	3,871	−2,934	5.814	1,366,216	31,034	1,397,250	26	58	XII—Brisk.
24	40.8	40.30	−.7	237,265	237,536	61.3	61.4	74	3,871	+2,383	6.003	1,424,357	27,666	1,452,023	26	59	III—Light.
25	40.4	39.97	−.3	230,689	234,715	59.6	60.6	74	3,871	−2,821	5.908	1,363,004	24,298	1,387,302	26	58	VI—Very light.
27	40	39.62	−.2	230,826	236,168	59.6	61	73.5	3,871	+1,453	6.089	1,405,505	*20,929	1,426,434	26	58	VII—Light.
30	39.8	39.37	−.2	228,420	234,730	59	60.6	72	3,871	−1,438	5.932	1,354,956	19,959	1,374,915	26	58	VI—Brisk.
31	39.6	39.15	−.2	229,709	236,870	59.3	61.2	73	3,871	+2,140	6.103	1,401,926	19,636	1,421,562	26	58	II—Light.
June 1	39.5	39.08	−.1	231,414	238,846	59.8	61.7	73.5	3,871	+1,976	6.004	1,389,470	19,313	1,408,783	26	58	III—Light.
2	39.3	38.98	−.1	228,576	236,395	59	61.1	71.5	3,871	−2,451	5.876	1,343,223	18,989	1,362,212	26	58	VI—Light.
3	39.2	38.88	−.1	230,975	239,182	59.7	61.8	72	3,871	+2,787	5.941	1,372,202	18,666	1,390,868	26	58	Do.
5	39.2	38.90	.0	228,270	236,399	59	61.1	71.5	3,871	−2,783	5.931	1,353,879	18,019	1,371,898	26	59	I—Light.
6	39.2	38.85	.0	227,941	236,264	58.9	61	71.5	3,871	−135	5.815	1,325,415	17,696	1,343,111	26	59	Do.
7	39.2	38.82	.0	229,302	237,741	59.2	61.4	73	3,871	+1,477	5.863	1,344,303	17,373	1,361,676	26	58	II—Brisk.
8	39.1	38.75	−.1	231,936	240,646	59.9	62.2	73	3,871	+2,905	5.822	1,350,225	17,049	1,367,274	25	58	III to XII—Very light.
Oct. 24	1.4	2.1	−.2	73,898	220,787	20.3	57	33	3,636	−19,859	2.323	171,646	.....	.....	24	45	VI—Moderate.

* Bank discharge observed. Crevasse at Keigers, 6 a. m., May 14.
† Crevasse at Lakeport, 4 a. m.
‡ Crevasse at Grand Lake, 9 p. m.
§ May 15 and 22, discharges not observed by regular methods; hence flanking results are here given.
¶ Crevasse discharge observed. See table of crevasses. Also observed June 10.

[Results by different methods of observing velocities with the current meter. Mean velocity is given in feet per second. Discharge is cubic feet per second. The column of "Difference" gives resulting difference between the two methods, "flanking" mean and "stationary." Bank discharge is not included in this table.]

Date.	Gauges.			Flanking method.						Stationary method.		Difference in discharge.	Remarks.
	Lake Providence.	Section.		Louisiana to Mississippi.		Mississippi to Louisiana.		Mean—					
		Louisiana.	Mississippi.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Velocity.	Discharge.	Mean velocity.	Discharge.		
1893.	*Feet.*	*Feet.*	*Feet.*										
Mar. 7	34.5	34.40	.....	.....	.....	.....	.....	.....	.....	5.463	1,032,497	.....	
9	35.2	34.84	.....	.....	.....	.....	.....	.....	.....	5.499	1,055,404	.....	
10	35.4	35.06	.....	5.469	1,074,164	.....	.....	.....	.....	5.445	1,069,479	.....	
11	35.6	35.26	35.12	.....	.....	.....	.....	.....	.....	5.317	1,064,936	.....	
13	35.7	35.36	35.15	.....	.....	.....	.....	.....	.....	5.428	1,015,849	.....	
14	35.6	35.22	35.03	.....	.....	.....	.....	.....	.....	5.523	1,077,256	.....	
15	35.4	34.92	34.75	.....	.....	.....	.....	.....	.....	5.592	1,085,111	.....	
16	35.1	34.55	34.44	5.323	1,037,313	.....	.....	.....	.....	5.591	1,089,516	.....	
17	34.8	34.38	34.22	.....	.....	.....	.....	.....	.....	5.480	1,044,950	.....	
18	34.5	33.98	33.88	.....	.....	.....	.....	.....	.....	5.589	1,025,991	.....	Floats give mean velocity, 5.499; discharge, 1,009,368.
20	34.1	33.58	33.40	.....	.....	.....	.....	.....	.....	5.408	1,010,642	.....	
21	33.9	33.38	33.20	.....	.....	.....	.....	.....	.....	5.410	f1,003,889	.....	Observed with floats; no meter observations this day. All results reduced to mean of vertical.
22	33.6	33.23	32.98	.....	.....	.....	.....	.....	.....	5.373	971,563	.....	
23	33.5	33.06	32.90	.....	.....	.....	.....	.....	.....	5.381	970,857	.....	
24	33.6	33.07	32.88	5.210	946,910	5.348	971,150	5.277	959,030	5.332	969,182	—10,152	
25	33.5	33.03	32.83	.....	.....	.....	.....	.....	.....	5.299	954,821	.....	
27	33.5	33.05	32.82	5.188	943,775	5.137	934,546	5.162	939,160	5.179	942,281	—3,121	
28	33.4	33.07	32.82	5.024	930,726	4.986	923,524	5.005	927,125	5.156	955,124	—27,999	
30	33.3	32.88	32.66	5.089	915,164	5.260	945,849	5.174	930,506	5.173	930,194	+312	
31	33.1	32.66	32.47	5.023	930,757	5.164	956,754	5.094	943,756	5.197	962,973	—19,217	
Apr. 1	32.9	32.46	32.23	4.789	884,205	4.933	910,810	4.861	897,508	5.023	927,470	—29,962	
3	32.2	31.85	31.57	4.724	850,793	4.714	849,062	4.719	849,928	4.918	885,829	—35,901	
4	31.8	31.45	31.20	4.653	865,438	4.644	863,794	4.649	864,616	4.770	887,224	—22,608	Floats give mean velocity, 4.718; discharge, 877,543.
5	31.3	30.88	30.61	4.522	814,853	4.678	842,798	4.600	828,826	4.701	847,094	—18,268	
6	30.6	30.20	29.95	4.760	842,608	4.768	844,147	4.764	843,378	4.736	837,264	+6,114	
7	30	29.55	.....	4.497	799,721	4.703	836,325	4.600	818,023	4.648	826,638	—8,615	
8	29.3	28.90	28.56	4.354	757,732	4.422	769,449	4.388	763,590	4.506	784,099	—20,509	
May 5	38	37.45	37.12	5.478	1,138,790	5.616	1,167,449	5.547	1,153,120	5.673	1,179,324	—26,204	
6	38.7	38.05	37.70	5.757	1,227,969	5.711	1,217,995	5.734	1,222,982	5.843	1,246,150	—23,168	
8	40.1	39.55	39.18	5.758	1,273,149	5.994	1,325,289	5.876	1,299,219	5.911	1,307,037	—7,818	
9	40.7	40.08	39.69	6.001	1,327,437	6.111	1,351,904	6.056	1,339,670	6.141	1,358,362	—18,692	
10	41.1	40.52	40.13	5.941	1,320,379	5.979	1,328,830	5.960	1,324,604	6.068	1,348,520	—23,916	
11	41.4	40.76	40.38	5.930	1,348,298	6.006	1,365,579	5.968	1,356,938	6.141	1,396,284	—39,346	Adams Front crevasse occurred.
12	41.4	40.82	40.47	6.043	1,362,627	6.213	1,400,973	6.128	1,381,800	6.134	1,383,005	—1,205	
13	41.5	40.92	40.55	5.895	1,339,747	6.028	1,369,777	5.962	1,354,762	6.066	1,378,604	—23,842	Keigers Front crevasse, May 14.

NOTE.—See pp. 2833 and 2834 for areas; areas are the same for all methods.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

[Results by different methods of observing velocities with the current meter. Mean velocity is given in feet per second. Discharge is cubic feet per second. The column of "Difference" gives resulting difference between the two methods, "flanking" mean and "stationary." Bank discharge is not included in this table.]

Date.	Gauges.			Flanking method.						Stationary method.		Difference in discharge.	Remarks.
	Lake Providence.	Section.		Louisiana to Mississippi.		Mississippi to Louisiana.		Mean—					
		Louisiana.	Mississippi.	Mean velocity.	Discharge.	Mean velocity.	Discharge.	Velocity.	Discharge.	Mean velocity.	Discharge.		
1893.	*Feet.*	*Feet.*	*Feet.*										
May 15	41.8	41.14	40.85	5.882 5.864 5.696 5.830	1,362,933 1,358,731 1,319,889 1,350,792	6.053 6.055 6.047 6.088	1,402,578 1,402,953 1,401,261 1,410,614	5.939	1,376,219	.....	.....	.....	Matthews Bend crevasse occurred.
16	41.8	41.14	40.84	5.823	1,323,448	6.002	1,364,187	5.912	1,343,818	5.944	1,351,121	−7,303	
17	41.8	41.15	40.86	5.663	1,303,981	5.811	1,338,170	5.737	1,321,076	5.847	1,346,321	−25,245	
18	41.8	41.11	40.83	5.719	1,330,520	5.861	1,363,451	5.789	1,346,986	5.842	1,359,301	−12,315	
19	41.8	41.11	40.83	5.753	1,322,206	5.957	1,369,295	5.855	1,345,750	5.947	1,366,852	−21,102	
20	41.8	41.10	40.82	5.697	1,317,066	5.826	1,346,796	5.761	1,331,931	5.868	1,356,704	−24,773	
22	41.8	41.08	40.84	*5.735 *5.793 *5.525 *5.483	1,364,507 1,378,384 1,314,563 1,304,536	5.805 5.922 5.627 5.662	1,381.165 1,408,975 1,338,855 1,347,145	5.814 5.574	1,383,258 1,326,274	.....	.....	.....	Wylys crevasse occurred 9 miles below discharge section.
23	41.7	41.09	40.83	5.672	1,332,801	5.784	1,359,269	5.728	1,346,035	5.814	1,366,216	−20.181	
24	40.8	40.45	40.15	5.813	1,379,303	5.958	1,413,668	5.886	1,396,486	6.003	1,424,357	−27,871	
25	40.4	40.13	39.81	5.732	1,322,215	5.966	1,376,392	5.849	1,349,304	5.908	1,363,004	−13,700	
27	40	39.78	39.45	5.939	1,370,762	6.052	1,403,800	6.010	1,387,281	6.089	1,405,505	−18,224	
30	39.8	39.50	39.24	5.953	1,359,866	6.212	1,418,892	6.083	1,389,376	5.932	1,354,956	+34,420	
31	39.6	39.30	39							6.103	1,401,926	.....	
June 1	39.5	39.20	38.95	5.874	1,359,378	6.031	1,395,729	5.953	1,377,554	6.004	1,389,470	−11,916	
2	39.3	39.10	38.85	5.836	1,334,074	5.853	1,338,002	5.845	1,336,038	5.876	1,343,223	−7,185	
3	39.2	39.04	38.72	5.587	1,290,361	5.819	1,344,017	5.703	1,317,189	5.941	1,372,202	−55,013	
5	39.2	39.04	38.75	5.801	1,324,256	5.939	1,355,795	5.870	1,340,026	5.931	1,353,879	−13,853	
6	39.2	39	38.70	5.802	1,322,515	5.843	1,331,869	5.823	1,327,192	5.815	1,325,415	+1,777	
7	30.2	38.95	38.68	5.672	1,300,609	5.835	1,337,928	5.753	1,319,268	5.863	1,344,303	−25,035	
8	39.1	38.90	38.60	5.733	1,329,642	5.879	1,363,451	5.806	1,346,546	5.822	1,350,225	−3,679	
Oct. 24	1.4	2.1	.....	2.416	178,574	1.781	131,577	2.099	155,076	2.323	171,646	−16,570	

Observed at 20 feet and 40 feet, respectively, and reduced by vertical factors.

RED RIVER LANDING, LA.

[Datum line taken on the Red River Landing gauge at 47.73 feet for the upper section and 47.72 feet for the lower section. The zero of this gauge is 23.85 feet above the Cairo datum plane. All velocities measured with meter except those of June 29 and July 1, which were with floats and are marked f.]

Section at Red River Landing.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Red River Landing.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
May 23*	44.18	.....	+0.1	199,336	213,641	49.4	52.8	72.3	4,038	.....	5.316	1,059,750	4,920	1,064,670	23	23	From right bank; light.
24†	44.28	.....	+.1	207,929	221,830	51.5	54.9	80.8	4,038	+8,189	5.269	1,095,480	;4,940	1,100,420	23	23	Do.
26*	44.40	.....	.0	208,243	221,659	51.6	54.8	79.6	4,038	—171	5.205	1,084,000	4,960	1,088,960	23	23	From left bank; light.
29†	44.48	.....	+.1	208,242	221,335	51.6	54.7	81.1	4,038	—324	5.113	1,064,688	4,970	1,069,658	24	24	Downstream (N.).
June 1*	44.49	.....	.0	208,152	221,208	51.5	54.7	82	4,039	—127	5.068	1,054,920	4,980	1,059,909	23	23	Light left bank wind.
3*	44.58	.....	+.1	218,564	231,262	54	57.2	80	4,044	+54	4.831	1,055,828	4,990	1,060,818	24	24	Upstream; light.
7†	44.96	.....	+.1	221,216	232,377	54.7	57.5	81.1	4,044	+1,115	4.901	1,084,176	5,060	1,089,236	24	25	Downstream; strong.
9*	45.21	.....	+.1	221,818	231,968	54.8	57.4	82	4,044	—409	5.067	1,123,924	5,100	1,129,024	24	25	Calm.
13†	45.72	.....	+.2	228,792	236,880	56.6	58.6	81.8	4,044	+4,912	5.055	1,156,544	5,190	1,161,734	24	25	Downstream; light.
17†	46.51	.....	+.2	224,136	229,033	55.3	56.6	82.7	4,050	—7,847	5.192	1,163,800	5,330	1,169,130	24	25	Calm.
22†	47.38	.....	+.2	229,596	230,971	56.8	57.1	81	4,044	+1,938	5.334	1,224,627	;5,483	1,230,110	24	25	Upstream; light.
24†	47.65	.....	+.1	227,775	228,058	56.3	56.4	83.5	4,044	—2,913	5.080	1,157,154	5,530	1,162,684	24	25	From left bank; light.
27†	47.72	.....	.0	228,036	228,036	56.4	56.4	83.3	4,044	—22	5.138	1,171,700	5,540	1,177,249	24	25	Calm.
July 10†	43.14	.....	—.8	205,870	224,378	51	55.5	76.7	4,038	—3,658	4.725	972,742	4,740	977,482	24	24	Downstream; light.

* p. m. † a. m. ; Observed.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

[Datum line taken on the Red River Landing gauge at 47.73 feet for the upper section and 47.72 feet for the lower section. The zero of this gauge is 23.85 above the Cairo datum plane. All velocities measured with meter except those of June 29 and July 1, which were with floats, and are marked *f*.]

Section one-half mile above Red River Landing, at Torras Landing.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge.		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Red River Landing.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.			Per second.	Over bank per second.				
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
May 24*	44.29	.....	+0.1	230,982	246,744	50.4	53.8	58.7	4,585	.....	4.600	1,062,566	.....	.....	23	24	From right bank; light.
26†	44.40	.....	.0	227,483	242.741	49.6	53	56.9	4,585	—4,003	4.847	1,102,677	.....	.....	23	24	From left bank; light.
29*	44.50	.....	+.1	234,197	248,977	51.2	54.4	62.6	4,573	+6,236	4.646	1,088,048	.....	.....	24	25	
June 3†	44.60	.....	+.1	240,163	254,498	52.4	55.5	60.6	4,580	+5,521	4.611	1,107,277	.....	.....	24	25	Do.
7*	44.98	.....	+.1	239,986	252,581	52.4	55.1	61.2	4,580	—1,917	4.605	1,105,073	.....	.....	24	25	Downstream; light.
9†	45.19	.....	+.1	243,788	255,421	53.2	55.8	67.1	4,580	+2,840	4.815	1,173,715	.....	.....	24	25	Calm.
13*	45.77	.....	+.2	251,640	260,617	54.9	56.9	63.9	4,580	+5,196	4.802	1,208,361	.....	.....	24	25	Downstream; strong.
17*	46.52	.....	+.2	252,582	258,124	55.1	56.4	66	4,580	—2,493	4.812	1,215,322	.....	.....	24	25	Calm.
20†	47.07	.....	+.2	255,998	258,335	55.7	56.4	65.4	4,580	+211	4.798	1,224,894	¶ 614	1,225,508	25	25	
24*	47.67	.....	+.1	260,014	260,289	56.8	56.8	63.9	4,580	+1,954	4.557	1,184,968	¶ 720	1,185,688	25	25	Downstream; light.
26†	47.73	.....	.0	262,331	262,331	57.3	57.3	66.5	4,580	+2,042	4.670	1,225,128	¶ 657	1,225,785	25	25	Calm.
27*	47.72	.....	.0	263,432	263,478	57.5	57.5	66.1	4,580	+1,147	4.603	1,212,580	¶ 994	1,213,574	25	25	Downstream; light.
28*‖	47.64	.....	.0	258,913	259,325	56.5	56.6	64.6	4,580	—4,153	.....	.....	.....	.....	.....	23	Downstream; high.
29†	47.60	.....	—.1	259,257	259,852	56.6	56.7	65.4	4,580	+527	*f* 4.419	*f* 1,145,578	994	1,146,572	25	25	Stormy.
29*	47.58	.....	.....	259,257	259,944	56.6	56.7	65.4	4,580	+92	*f* 4.764	*f* 1,235,116	994	1,236,110	25	25	Calm.
July 1*	47.24	.....	—.2	258,964	261,208	56.5	57	64.4	4,580	+1,264	*f* 4.404	*f* 1,140,601	¶ 548	1,141,149	24	24	Do.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	§4.601	§1,191,577	.....	.....	.....	.....	
9*†	43.84	.....	—.7	241,388	259,204	52.7	56.6	59.7	4,580	—2,004	4.229	1,020,812	.....	.....	25	25	
10*	42.97	.....	—.8	237,462	259,239	52	56.7	58.6	4,570	+35	4.201	997,477	.....	.....	24	25	

* p. m.
† a. m.
‡ Observed at middepth and reduced by vertical factor.
§ As observed at middepth.
‖ No velocities measured on account of high wind.
¶ Observed.

Discharge observations.

ATCHAFALAYA RIVER, SIMMSPORT, LA.

[Datum line taken at 48.10 and 48.03 feet for upper and lower sections, respectively, as observed June 21 on the Mississippi River Commission gauge at Barbre Landing. Zero of this gauge 24.17 feet above the Cairo datum plane. Velocities measured with Price meter No. 23.]

Section at Simmsport.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge.		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Barbre landing.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. ft.*	*Cu. feet.*			
May 27*	44.26	.....	0.0	58,789	62,775	57	60	84.5	1,030	.....	4.555	267,776	1,360	269,136	11	11	From left bank; light.
30*	44.41	.....	.0	59,410	63,244	57.6	60.4	87.5	1,031	+469	4.669	277,375	1,500	278,875	11	11	Do.
June 2†	44.51	.....	.0	59,370	63,104	57.5	60.3	85.7	1,032	−140	4.789	284,347	1,600	285,947	11	11	Do.
5*	44.74	.....	+.1	59,354	62,848	57.5	60	86.1	1,033	−256	4.685	278,088	1,800	279,888	11	11	Calm.
8*	45.28	.....	+.1	61,652	64,590	59.4	61.7	87.9	1,038	+1,742	4.712	290,522	2,280	292,802	11	11	From left bank; light.
10*	45.63	.....	+.2	61,754	64,330	59.4	61.4	87.9	1,039	−260	4.836	298,640	2,600	301,240	11	11	Downstream; light.
19*	47.75	.....	+.3	65,878	66,244	62.9	63.2	94.7	1,047	+1,914	4.951	326,131	‡4,487	330,618	11	12	Downstream; rain.
21†	48.10	.....	+.2	64,579	64,579	61.7	61.7	93	1,047	−1,665	5.227	337,585	‡4,953	342,538	12	13	Upstream; stiff.
July 11*‡	43.90	.....	−.6	61,305	65,656	59.9	62.7	89.9	1,024	+1,077	4.573	280,377	‡1,051	281,428	11	11	

Section three-fourths mile below Simmsport.

May 30†	44.41	.....	0.0	60,565	64,999	49.6	52.8	83.2	1,220	.....	4.656	281,975	.....	.....	12	13	From right bank; light.
June 2*	44.50	.....	.0	60,971	65,295	50	53.1	84.5	1,220	+296	4.811	293,332	.....	.....	11	12	Do.
5*	44.78	.....	+.1	60,782	64,763	49.8	52.6	83.8	1,220	−532	4.848	294,648	.....	.....	11	12	Do.
8*	45.26	.....	+.1	62,293	65,686	51.1	53.4	84.6	1,220	+923	4.736	295,013	.....	.....	11	12	Upstream; light.
10†	45.67	.....	+.2	62,766	65,657	51.4	53.4	85	1,220	−29	5.180	325,133	.....	.....	12	13	Calm.
14*	46.54	.....	+.2	64,890	66,715	53.2	54.2	88.5	1,220	+1,058	5.055	328,042	.....	.....	13	13	Do.
21†	48.03	.....	+.2	65,379	65,379	53.2	53.2	89.5	1,230	−1,386	5.495	359,244	.....	.....	13	13	Upstream; stiff.
July 11*	43.95	.....	−.6	61,352	66,350	50.3	53.9	82.1	1,220	+971	4.790	293,881	.....	.....	12	13	

* a. m. † p. m. ‡ Observed; interpolated for other days.

Over-bank discharge is that of Alligator Bayou, which comes into the Atchafalaya just below the discharge section.

Discharge observations—Continued

ARKANSAS RIVER, LITTLE ROCK, ARK.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge.		Total discharge of river per second.	No. of velocity stations.	No. of sounding.	Direction and force of wind.
	Little Rock.*	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.			Per second.	Over bank per second.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
May 6	25.2	24	—1.2	42,796	42,796	22.9	22.9	29	1,866	.....	4.601	196,907	.....	.....	14	31	X—Light.
7	23.8	22.1	—1.5	40,325	43,867	21.6	23.5	28	1,862	+1,071	4.524	182,413	.....	.....	14	33	IX—Light.
8	22.5	21.45	—1.2	39,470	4,4223	21.2	23.7	25.5	1,862	+356	4.011	158,297	.....	.....	14	37	XII—Calm to light.
9	22.2	20.9	—.4	37,504	43,282	20.1	23.2	25.5	1,862	—941	3.781	141,821	.....	.....	14	32	X—Brisk.
10	22.5	20.77	+.4	37,338	43,359	20.1	23.2	24	1,862	+77	3.986	148,817	.....	.....	14	29	XI—Light.

* Engineer gauge in Capt. Willard's charge; elevation of zero, 241.55 feet above the Cairo datum plane. Datum line taken at 24 feet on "local" gauge, as tabulated, observed May 6.

NOTES.—Discharge section, 7,710 feet below the Little Rock and Fort Smith Railroad bridge and about 2,900 feet below the lower range of last year. The upper and lower ranges were 400 feet apart and the discharge section midway between them. Surface floats used; nine-tenths of the surface velocity used in finding the discharge. No observations were made to determine the ratio of mean to surface velocity; the above reduction factor was assumed by the observer and adopted in this recomputation.

WHITE RIVER, CLARENDON, ARK.

1893																	
May 5	* 29.8	.....	+0.9	16,382	18,650	29	32.8	36.5	565	.....	3.730	61,103	70,299	131,402	.....	.....	
6	30.7	.....	+0.9	17,093	18,851	30.3	33.1	37.5	565	+201	3.659	62,544	81,725	144,267	.....	.....	
8	32.7	.....	+1	18,135	18,759	32	32.9	39.5	567	—92	3.909	70,898	109,494	180,392	.....	.....	
9	33.4	.....	+.8	18,526	18,753	32.7	32.9	40	567	—6	4.092	75,813	114,651	190,464	.....	.....	
10	33.8	.....	+.4	19,420	19,420	34.1	34.1	42.5	569	+667	4.226	82,062	119,808	201,870	.....	.....	

* Standard Mississippi River Commission gauge read by discharge party, datum line taken at 33.8 feet on this gauge as observed May 10.

NOTES.—The river discharge section was about 1,100 feet above the bridge at Clarendon; the section used for the bank discharge was at the bridge along the trestle-work, for about 15,300 feet of water width, to high ground. The meter stations along the trestle were 300 to 600 feet apart, the meter held at one foot below the water surface. In the main river the meter was run at six-tenths depth, stations about 100 feet apart; the velocities have been applied as observed in all cases. Price meter No. 5 was used; the river discharge was computed with rating of 1892 ($y=3.69243\ x+0.3697$); the bank discharge, having very low velocity, was computed with a low velocity rating made August 28, 1893, ($y=3.55173\ x+0.2012$). The bank discharge was measured May 6, 8, and 10; that given for 5th deduced from 6th by correcting for change of stage; that given for the 9th is the mean of 8th and 10th. The bank discharge area observed May 6 was 98,499 square feet; this, corrected for change of stage, was used for other days, giving for May 10, 141,366 square feet. Results of discharge observations at this station in 1879 and 1892 are given in the appendix.

Results of final reduction of rating observations with Price current meters, 1893.

[Meter No. 5, used at Clarendon, Ark.; No. 23, at Red River Landing and Simmesport, La.; No. 29, at New Madrid, Mo., also at Helena, Ark., after May 23; No. 39, at Wilson Point, La.; No. 43, at Helena, Ark., to May 23.]

No. of meter.	Date.	a.	b.	Observations. Number.	Observations. Water.*	Length of base.	Limits of observed velocity.		Locality.
						Feet.	*Feet per second.*		
5	Aug. 28, 1893	3.55173	+0.2012	9	Still	100	0.4 to	1.4	Third district.
23	May 22, 1893	3.85378	+.4087	20	Running	900	3.6	9.7	West of Red River Dam, in a chute.
	July 12, 1893	3.76915	+.5294	28	....do	900	2	10.7	Red River Landing.
	Weighted means	3.79722	+.5012						
29*	Jan. 31, 1893 / Feb 1, 1893	3.81012	+.45000	34	Still	201.3	3.8	10.9	New Madrid.
29†	Jan. 31, 1893 / Feb. 1, 1893	4.41957	−.19987	34	....do	201.3	.8	4.5	Do.
39*	Mar. 31, 1893	3.76372	+.4683	22	Running	600	2.3	10.2	Ashton, La.
	May 4, 1893	3.67346	+.6860	28	....do	600	4	9.1	Do.
	Weighted means	3.73452	+.5288						
39†	May 10, 1893	4.0593	+.2449	15	Still	200	.7	2.3	Wilson Point, La.
43	Mar. 2, 1893	3.9963	+.1262	12	....do	365.5	.9	7.6	Helena, Ark.

*Used for higher velocities.

†Used for lower velocities.

Results of discharge observations, Mississippi River.

CARROLLTON, LA.

Upper section.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Carrollton.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.			Per second.	Over bank per second.				
1893.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
June 3	15.6	.....	0.0	175,686	180,205	72.4	74.3	106.5	2,426	.....	5.665	995,274	.....	.....	15	16	S.—Light.
8	15.8	.....	+.1	178,418	182,542	73.5	75.2	104.9	2,426	+2,247	5.620	1,002,712	.....	.....	15	16	Upstream; strong.
9	15.9	.....	+.1	178,576	182,458	73.6	75.2	104.8	2,426	—84	5.732	1,023,614	.....	.....	15	16	Down; off left bank; light.
12	16.2	.....	.0	181,592	184,746	74.9	76.2	104.4	2,426	+2,288	5.664	1,028,527	.....	.....	15	16	E.—Light.
15	16.8	16.8	+.3	180,621	182,319	74.5	75.2	103.5	2,426	—2,427	5.577	1,007,392	.....	.....	15	16	NW.—Light.
16*	16.55	16.60	.0	184,614	186,846	76.1	77	105.1	2,426	+4,527	5.604	1,034,635	.....	.....	15	16	SW.—Light.
17*	16.45	16.47	.0	185,612	188,135	76.5	77.5	105.2	2,426	+1,280	5.745	1,066,264	.....	.....	15	16	NE.—Light.
19†	17	17	+.1	187,311	188,524	77.2	77.7	106	2,426	+389	5.816	1,089,438	.....	.....	15	16	S.—Strong.
21†	17.20	17.20	+.2	190,564	191,292	78.6	78.9	108.8	2,426	+2,768	5.875	1,119,640	.....	.....	15	16	SW.—Strong.
22*	17.30	17.40	+.2	191,086	191,450	78.8	78.9	108.8	2,426	+158	5.824	1,112,819	.....	.....	15	16	SW.—Light.
23†	17.50	17.50	.0	191,524	191,524	78.9	78.9	107	2,426	+74	5.777	1,106,417	.....	.....	15	16	NW.—Light.
24†	17.25	17.30	.0	193,059	193,593	79.6	79.8	108.1	2,426	+2,069	5.846	1,128,539	.....	.....	15	16	NW.—Light.
26*	17	17.20	—.2	193,985	194,955	80	80.4	106.7	2,426	+1,362	5.614	1,088,975	.....	.....	15	16	Calm.
26†	17	17.10	—.2	193,985	.....	80	.....	106.7	2,426	.....	5.606	1,087,574	.....	.....	15	16	Calm.
28†	16.80	16.80	—.2	191,412	193,110	78.9	79.6	105.5	2,426	—1,845	5.510	1,054,715	.....	.....	15	16	NE.—Light.
30†	16.55	16.60	.0	189,166	191,398	78	78.9	106	2,426	—1,712	5.479	1,036,453	.....	.....	15	16	NE.—Light.
July 1	16.35	16.40	.0	189,935	192,652	78.3	79.4	107	2,426	+1,254	5.390	1,023,737	.....	.....	15	16	NW.—Very light.
3*	16.10	16.10	—.1	186,871	190,267	77	78.4	105.6	2,426	—2,385	5.451	1,018,622	.....	.....	15	16	NW.—Light.

Lower section.

June 13	‡16.20	.....	+0.1	183,741	186,097	74.1	75	111.6	2,480	.....	5.560	1,021,683	.....	.....	15	15	E.—Light.
15	16.75	16.60	+.3	181,407	182,573	73.1	73.6	110.1	2,480	—3,524	5.537	1,004,396	.....	.....	15	15	NW.—Light.
16†	16.60	16.60	.0	182,030	183,394	73.4	73.9	111.0	2,480	+821	5.665	1,031,228	.....	.....	15	15	SE.—Strong.
17†	16.55	16.50	.0	182,399	183,961	73.5	74.2	111.0	2,480	+567	5.762	1,051,000	.....	.....	15	16	SE.—Strong.
19*	16.65	16.55	+.1	185,992	187,356	75	75.5	112.5	2,480	+3,395	5.930	1,102,979	.....	.....	15	15	S.—Strong.
21*	16.95	16.90	+.2	180,584	180,906	72.8	72.9	112.4	2,480	—6,450	5.987	1,081,132	.....	.....	15	15	S.—Rough river.
22†	17.20	17.05	+.2	182,774	182,848	73.7	73.7	111.6	2,480	+1,942	5.880	1,075,895	.....	.....	15	15	W.—Light.
23*	17.15	17.15	.0	185,004	185,004	74.6	74.6	111.6	2,480	+2,156	6	1,110,490	.....	.....	15	15	NW.—Light.
24*	17.05	16.95	.0	183,701	184,073	74.1	74.2	111.7	2,480	—931	5.890	1,082,091	.....	.....	15	15	NW.—Light.

	24†	17.	16.95	.0	183,701		74.1		111.7	2,480		5,857	1,075,982			NW.—Light.
	25*	16.80	16.75	.2	181,768	182,686	73.3	73.7	111.2	2,480	−1,387	5,842	1,061,862			N.—Very light.
	26†	16.80	16.75	−.2	181,768	182,686	73.3	73.7	111.2	2,480		5,836	1,060,849			Calm.
	27†	16.65	16.55	−.2	186,515	187,879	75.2	75.8	111	2,480	+5,193	5,664	1,056,490			NE—Light.
	28*	16.45	16.45	−.2	183,483	185,219	74	74.7	111.1	2,480	−2,660	5,685	1,048,117			NE—Light.
	30*	16.35	16.30	.0	181,035	183,093	73	73.8	110.8	2,480	−2,126	5,767	1,043,998			NE—Light.
July	1*	16.10	16	.0	178,990	181,718	72.2	73.3	110.1	2,480	−1,375	5,729	1,025,439			NW—Very light.
	3†	15.85	15.75	−.1	176,244	179,592	71.1	72.4	108.2	2,480	−2,126	5,694	1,003,555			NW—Light.

*A. M. †P. M. ‡Section gauge L. B.

Datum line taken at 17.5 feet as observed by the discharge party June 23, 1893, on the Carrollton gauge. The distance between stations ranged from 100 to 250 feet. End stations were 86 and 90 feet from shore.

Discharge sections.—The upper section is at foot of St. Charles street and the lower section at foot of General Scott street; the distance between the sections, on the left bank, is about 4,300 feet.

Gauges.—The gauge readings tabulated were observed by the discharge party, one gauge being at each end of section; the first column gives left bank gauge and the second gives the right bank gauge. The "rise or fall" column was computed from the standard Carrollton record furnished by Capt. Willard.

Datum line for lower section taken at 17.15 feet on section gauge as observed June 23, 1893.

The velocity and sounding stations were coincident and were located at same position each day by means of range signals on left bank.

On the lower section the distance between stations ranged from 60 to 250 feet; the end station at left bank was 80 feet from shore and end station at right bank was 200 feet from shore.

The velocities were measured with Price meter No. 22, which was run for two minutes at each station and generally at three-tenths depth. At a few of the stations the meter immersion was four-tenths, five-tenths, and six-tenths depth. The velocities at these different depths were reduced to the mean of the vertical by multiplying by the following factors, taken from Price's table:

Three-tenths, 0.948; four-tenths, 0.953; five-tenths, 0.960; six-tenths, 0.965.

The meter was rated July 5, 1893, in the Company Canal, the resulting equation, from least square reduction, being $y = 3.89834\,x + 0.2826$; in which y = velocity in feet per second and x = registrations per second of meter.

The velocities at ends of section for areas between the end velocity stations and shore were obtained by taking four-fifths of the velocity observed at the end station; except in the lower section at right bank, where the end station is 200 feet from shore and in the middle of this the observer's map states "cluster of piles" is located, hence in this case half of the velocity observed at end station is applied over this obstructed portion, the area of which amounted to between 5,000 and 6,000 square feet. The velocity at this end station ranged from about 2.5 to 3.5 feet per second.

Assistant Engineer William Garvin was chief of party.

*Crevasse measurements, 1893, Mississippi River, third district.**

Station.	Distance, right bank.†	Date of observation.	Area.	Width between ends of levee.	Mean depth.	Mean velocity per second.	Discharge per second.	Date of break.	Method.	Remarks
	Miles.		*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*			
Lake Port, Ark. (Adams front).	497	May 13	11,843	618	.....	5.47	64,726	May 11, 4 a. m.	Meter No. 5.....	Reading of Greenville gauge, 43.8.
		May 19	19,425	803	6.77	4.39	85,238		....do	Reading of Greenville gauge, 44.
		June 10	20,154	1,259	16	3.44	69,493		Meter No. 39.....	Reading of Greenville gauge, 43.2.
Keigers.....	505	May 20	10,430	339	14.7	1 43	14,871	May 14, 6 a. m.	Meter No. 5.....	Reading of Greenville gauge, 44.
		June 9	14,372	774	18.6	3.28	47,093		Meter No. 39.....	Reading of Greenville gauge, 43.3.
Grand Lake (Matthews Bend, two openings).	508	May 20	10,040	989	10.1	4.12	‡ 41,428	May 15, 9 p. m.	Meter No. 5.....	Reading of Greenville gauge, 44.
		May 20	5,500	560	9.82	3.32	‡ 18,235		....do	
		June 9	14,194	1,672	8.4	1.72	‡ 24,409		Surface floats.....	Reading of Greenville gauge, 43.3.
		June 9	5,102	652	7.8	2.76	‡ 14,115		....do	
Wylys.....	545	May 26	.....	.....	.....	.....	209,010	May 23, 11 a. m.	Meter	Reading of Lake Providence gauge, 40.2.
		May 29	.....	2,950	.....	.....	230,193		....do	Reading of Lake Providence gauge, 39.9.
Cypress Creek (Cypress Creek Levee, station 202).§	.....	June 6	.....	.....	.....	.....	89,235	May 29, 4 a. m.	Meter No. 5.....	Reading of Arkansas City gauge, 49.6.

* Results of reduction in third district office. † Distance is referred to Cairo. ‡ Discharge measured in line of break.

§Cypress Creek crevasse occurred at 4 a. m. and by 7 a. m. was 200 feet wide; at 6 p. m. it was 550 feet wide. The levee was 10 feet high and 4 feet crown. Meter No. 5 submerged from 5 inches to 3 feet. 0.8 to 0.98 of observed velocity taken for mean. Velocities were estimated for part of discharge. Width June 6 from station, 192+50 to 203+40 = 1,090 feet.

Slope observations, Mississippi River.

[Results of reduction at office of first and second districts engineer.]

COLUMBUS, KY.

Date.	Belmont gauge.	Maximum surface velocity per second—			Slope: sine of inclination.	
		At section.	At upper range.	At lower range.	Between upper range and section.	Between lower range and section.
1893.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Feb. 20	36.3				.0000591	
22	38.5		5.60	7.14	671	
23	39.1		7.20		617	
24	39.7		7.20	6.52	752	
25	40.1	7.86	7.50	7.14	671	.0000280
27	40.5	8.33	6.67		470	667
28	40.73		7.20	7.70	738	336
Mar. 1	40.73	8.21	6.92	6.67	806	336
2	40.4	7.86	6.67		806	234
6	33.6		4.90	6	752	000
May 5	43.15	8.75			723	
6	43.40	10			603	
7	43.70				603	
8	43.80	8.75			627	
9	43.82	8.75			663	
10	43.80	9.50			699	
11	43.77	9.17			687	
12	43.78	8.60			687	
13	43.75	9.48			747	
15	43.65	8.75			868	
16	43.36	9.01			747	
17	42.90	8.87			747	
18	42.32	9.17			639	
19	41.56	8.75			675	
20	40.35	8.33			590	

NOTE.—February and March series. Sine of slope inclination calculated from reading of upper, lower, and section gauges at mean time of float observations. From upper range to section = 7,450′. From section to lower range = 1,785′. Omissions and apparent discrepancies in surface velocity columns due to prevailing winds. May series, upper range and gauge are 8,300 feet above discharge section, scaled along middle of channel.

NEW MADRID, MO.

[Distance between the two gauges, 26,500 feet.]

Date.	New Madrid gauge.	Maximum surface velocity per second—		Slope; sine of inclination.	Date.	New Madrid gauge.	Maximum surface velocity per second—		Slope; sine of inclination.
		At upper gauge.	At lower gauge.				At upper gauge.	At lower gauge.	
1893.	*Feet.*	*Feet.*	*Feet.*		1893.	*Feet.*	*Feet.*	*Feet.*	
Feb. 23	33.10		6.23	.0000977	May 6	37.03	7.41		.0001879
24	33.60	6	6.25	977	8	37.87	6.73		
25	33.97	6.08	5.93	966	9	38.06	5.84		1887
27	34.55	6.42	5.80	959	10	38.10	7.12		1864
28	34.73	6.08	6.38	970	11	38.08	6.31		1864
28	34.73	5.97			12	38.04	6.72		1868
Mar. 1	34.88	5.97	6.33	1000	13	37.98	6.20		1861
2	34.91	6.42	6.17	1004	15	37.94			1879
3	34.70			995	16	37.76			1875
5	33	5.22	6.42	977	17	37.50	6.58		1849
6	30.90			977	18	37.06	6.13		1815
7	28.51			981	19	36.49			1819
May 4	36			1842	20	35.90			1823
5	36.53	5.93		1872					

Slope observations, Mississippi River—Continued

HELENA, ARK.

[Distance between Helena gauge and lower gauge, 12,200 feet. The sine of the slope inclination was computed from the difference of gauge readings at the mean time of discharge observation.]

Date.	Helena gauge.	Maximum surface velocity per second—		Slope; sine of inclination.	Date.	Helena gauge.	Maximum surface velocity per second—		Slope; sine of inclination.
		At Helena gauge.	At lower gauge.				At Helena gauge.	At lower gauge.	
1893.	*Feet.*	*Feet.*	*Feet.*		1893.	*Feet.*	*Feet.*	*Feet.*	
May 9	43.14	2.53	3.57	.0000623	May 19	45.22	5.16	8.71	.000689
10	43.34	3.94	7.58	566	20	45.72	4.50	8.13	672
11	43.49	4.61	8.48	566	22	46.89	6.43	9.07	664
12	43.70	5.09	8.89	623	23	47.48	.....	8.80	721
13	43.81	4.90	7.58	631	25	47.90	9	8.40	8360
15	44.20	4.87	8.80	[?] 263	26	47.80	9.05	8.74	8443
16	44.40	5.20	7.53	623	29	47	9	8.59	8115
17	44.60	5.12	8.07	648	June 1	45.85	8.73	8.77	8115
18	44.89	5.34	8.88	623					

ARKANSAS CITY, ARK.

[Results of reduction at office of third district engineer.]

Date.	Side.	Gauges.*		Slopes, sine of inclination.	
		Middle upper.	Middle lower.	Middle to section.	Section to middle.
1893.		*Feet.*	*Feet.*		
Mar. 9	Arkansas	43.05	42.95	.000011	.000072
	Mississippi	42.84	42.49	50	086
10	Arkansas	43.18	43.12	00	033
	Mississippi	43.03	42.64	63	087
11	Arkansas	43.20	43.15	09	011
	Mississippi	43.04	42.49	83	130
13	Arkansas	42.86	42.85	07	011
	Mississippi	42.74	42.39	33	110
18	Arkansas	40.60	40.55	07	017
	Mississippi	40.54	40.19	67	065
20	Arkansas	40.15	40.05	25	017
	Mississippi	40.09	39.69	67	037
21	Arkansas	39.95	39.90	07	017
	Mississippi	39.94	39.49	10	087
22	Arkansas	39.85	39.75	07	014
	Mississippi	39.81	39.41	73	078
24	Arkansas	39.85	39.75	07	044
	Mississippi	39.79	39.39	67	087
25	Arkansas	39.90	39.82	07	033
	Mississippi	39.87	39.54	67	071
27	Arkansas	39.95	39.88	25	000
	Mississippi	39.94	39.49	67	110
29	Arkansas	39.85	39.80	07	017
	Mississippi	39.84	39.34	83	110
30	Arkansas	39.65	39.60	07	017
	Mississippi	39.64	39.24	83	065
31	Arkansas	39.15	39.10	71	017
	Mississippi	39.15	38.88	53	048
Apr. 1	Arkansas	38.95	38.90	00	025
	Mississippi	38.92	38.52	83	065
3	Arkansas	37.78	37.65	18	044
	Mississippi	37.67	37.41	43	070
4	Arkansas	37.28	37.12	36	033
	Mississippi	37.16	37.85	57	061
5	Arkansas	36.52	36.38	29	017
	Mississippi	36.39	36.19	43	043
6	Arkansas	35.75	35.63	43	000
	Mississippi	35.64	35.39	43	065
7	Arkansas	34.90	34.85	14	006
	Mississippi	34.89	34.54	43	110
8	Arkansas	34.25	34.14	43	.....
	Mississippi	34.19	.....	50	.....

* For gauge readings at section, see tabulated discharge results. For location of gauges, see p. 2813.

Slope observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

[Results of reduction at office of third district engineer.]

Date.	Side.	Gauges.*		Slopes, sine of inclination.	
		Upper.	Lower.	Upper.	Lower.
1893.		*Feet.*	*Feet.*		
May 5	Arkansas	45.97		.000013	
	Mississippi		45.31		
6	Arkansas	46.85		022	
	Mississippi	46.71	46.14	123	.000091
8	Arkansas	48.01		009	
	Mississippi	47.79	47.21	100	127
9	Arkansas	48.40		000	
	Mississippi	48.19	47.64	107	125
10	Arkansas	48.68		006	
	Mississippi	48.47	47.89	113	109
11	Arkansas	48.85		000	
	Mississippi	48.71	48.09	157	068
12	Arkansas	49.01		009	
	Mississippi	48.79	48.24	116	091
13	Arkansas	49.13		013	
	Mississippi	48.96	48.39	123	091
15	Arkansas	49.45		022	
	Mississippi	49.23	48.71	120	073
16	Arkansas	49.59		028	
	Mississippi	49.38	48.77	139	091
17	Arkansas	49.60		028	
	Mississippi	49.41	48.77	140	100
18	Arkansas	49.60		022	
	Mississippi	49.38	48.77	023	123
19	Arkansas	49.56		013	
	Mississippi	49.30	48.76	096	105
20	Arkansas	49.51		003	
	Mississippi	49.36	48.73	133	105
22	Arkansas	49.55		000	
	Mississippi		48.74		100
23	Arkansas	49.63		016	
	Mississippi	49.46	48.84	156	068
24	Arkansas	49.78		028	
	Mississippi	49.50	48.98	103	091
25	Arkansas	49.89		025	
	Mississippi	49.71	49.09	153	073
26	Arkansas	49.88		013	
	Mississippi	49.74	49.09	134	113
27	Arkansas	50.01		025	
	Mississippi	49.79	49.19	150	068
29	Arkansas	50.20		038	
	Mississippi	49.96	49.37	140	077
31	Arkansas	49.95		006	
	Mississippi	49.61	48.99	156	068
June 1	Arkansas	49.63		006	
	Mississippi	49.39	48.79	116	113
2	Arkansas	49.39		004	
	Mississippi	49.33	48.69	163	068
3	Arkansas	49.50		006	
	Mississippi	49.26	48.74	116	077
5	Arkansas	49.54		028	
	Mississippi	49.31	48.74	123	081
7	Arkansas	49.47		013	
	Mississippi	49.41	48.69	140	136

*For gauge readings at section, see tabulated discharge results. For location of gauges, see p. 2813. Extreme upper and lower gauges, not observed in May-June series.

Slope observations, Mississippi River—Continued.

WILSON POINT, LA.

[Results of reduction at office of third district engineer. Minus sign indicates a reverse slope.]

Date.	Side.	Gauges.*		Slopes, sine of inclination.	
		Upper.	Lower.	Upper.	Lower.
1893.		*Feet.*	*Feet.*		
Mar. 9	Louisiana	35.05	34.82	.0000942	.0000098
10	Louisiana	35.32	35.03	1065	147
11	Louisiana	35.46	35.23	0819	147
	Mississippi	34.90	35.05	—1716	353
13	Louisiana	35.57	35.30	0860	295
	Mississippi	35.07	35.10	—0429	252
14	Louisiana	35.46	35.17	0893	246
	Mississippi	34.91	35	—0643	151
15	Louisiana	35.15	34.87	0942	246
	Mississippi	34.65	34.65	—0536	504
16	Louisiana	34.83	34.54	1147	049
	Mississippi	34.57	34.42	—0375	101
17	Louisiana	34.60	34.32	0901	295
	Mississippi	34.08	34.15	—0751	352
18	Louisiana	34.32	33.93	1392	246
	Mississippi	33.82	33.85	—0322	151
20	Louisiana	33.78	33.53	0819	246
	Mississippi	33.33	33.37	—0375	151
21	Louisiana	33.58	33.33	0819	246
	Mississippi	33.12	33.15	—0429	252
22	Louisiana	33.43	33.15	0819	393
	Mississippi	32.92	32.96	—0322	101
23	Louisiana	33.28	33	0901	295
	Mississippi	32.83	32.85	—0429	252
24	Louisiana	33.28	33	0860	344
	Mississippi	32.82	32.85	—0322	151
25	Louisiana	33.26	32.96	0942	344
	Mississippi	32.80	32.80	—0161	151
27	Louisiana	33.23	32.95	0737	491
	Mississippi	32.78	32.78	—0214	202
28	Louisiana	33.26	32.95	0778	590
	Mississippi	32.78	32.80	—0214	101
30	Louisiana	33.08	32.78	0819	491
	Mississippi	32.60	32.62	—0322	202
31	Louisiana	32.90	32.57	0983	442
	Mississippi	32.40	32.42	—0375	252
Apr. 1	Louisiana	32.65	32.35	0778	541
	Mississippi	32.18	32.20	—0268	151
3	Louisiana	32	31.70	0614	747
	Mississippi	31.50	31.52	—0375	252
4	Louisiana	31.58	31.26	0532	934
	Mississippi	31.12	31.10	—0429	504
5	Louisiana	30.08	30.70	0410	885
	Mississippi	30.55	30.53	—0322	402
6	Louisiana	30.33	30.05	0532	737
	Mississippi	29.90	29.93	—0268	101
7	Louisiana	29.70	.....	0614	.....
8	Louisiana	29.15	28.70	1024	983
	Mississippi	28.50	28.53	—0322	151
May 5	Louisiana	37.55	37.14	0408	1570
	Mississippi	36.97	37.15	—0771	—0157
6	Louisiana	38.16	37.74	0445	1570
	Mississippi	37.55	37.72	—0771	—0105
8	Louisiana	39.65	39.15	0408	2025
	Mississippi	39	39.19	—0925	—0052
9	Louisiana	40.23	39.76	0812	1620
	Mississippi	39.53	39.75	—0823	—0314
10	Louisiana	40.65	40.18	0531	1722
	Mississippi	39.93	40.18	—1028	—0262
11	Louisiana	40.87	40.46	0449	1519
	Mississippi	40.25	40.45	—0666	—0367
12	Louisiana	40.93	40.52	0449	1519
	Mississippi	40.34	40.50	—0666	—0157
13	Louisiana	41.03	40.62	0449	1519
	Mississippi	40.42	40.59	—0666	—0210
15	Louisiana	41.28	40.91	0574	1671
	Mississippi	.....	40.89	.....	0210
16	Louisiana	41.28	40.91	0674	1165
	Mississippi	40.69	40.88	—0771	—0210
17	Louisiana	41.29	40.90	0574	1286
	Mississippi	40.69	40.89	—0874	—0157
18	Louisiana	41.26	40.87	0612	1210
	Mississippi	40.64	40.85	—0977	—0105
19	Louisiana	41.26	40.87	0612	1210
	Mississippi	40.64	40.85	—0977	—0105

Slope observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

[Results of reduction at office of third district engineer. Minus sign indicates a reverse slope.]

Date.	Side.	Gauges.*		Slopes, sine of inclination.	
		Upper.	Lower.	Upper.	Lower.
1893.		*Feet.*	*Feet.*		
May 20	Louisiana	41.25	40.86	.0000612	.0001210
	Mississippi	40.61	40.85	—1080	—0157
22	Louisiana	41.23	40.85	0612	1165
	Mississippi	40.62	40.85	—1131	—0052
23	Louisiana	41.26	40.86	0694	1165
	Mississippi	40.58	40.85	—1285	—0105
24	Louisiana	40.63	40.20	0735	1266
	Mississippi	39.95	40.18	—1028	—0157
25	Louisiana	40.28	39.87	0612	1316
	Mississippi	39.65	39.88	—0823	—0367
27	Louisiana	39.94	39.54	0653	1210
	Mississippi	39.30	39.53	—0771	—0419
30	Louisiana	39.67	39.28	0694	1114
	Mississippi	39.05	39.30	—0977	—0314
31	Louisiana	39.50	39.07	0816	1165
	Mississippi				
June 1	Louisiana	39.38	38.95	0735	1266
	Mississippi		38.98		—0157
2	Louisiana	39.23	38.85	0531	1266
	Mississippi	38.57	38.85	—1434	0000
3	Louisiana	39.18	38.80	0574	1210
	Mississippi	38.50	38.78	—1131	—0314
5	Louisiana	39.18	38.80	0574	1210
	Mississippi	38.50	38.80	—1285	—0262
6	Louisiana	39.14	38.75	0574	1266
	Mississippi		38.75		—0262
7	Louisiana	39.08	38.70	0531	1266
	Mississippi		38.70		—0105
8	Louisiana	39.03	38.65	0531	1266
	Mississippi		38.65		—0262

* For location of gauges see pp. 2816 and 2817. For gauge readings at section see tabulated discharge results.

APPENDIX.

The following tabulated results of discharge observations of 1879, not heretofore published, are inserted herein at request of Lieut. Col. C. R. Suter.

J. G. WARREN,
Captain of Engineers,
Secretary Mississippi River Commission.

***Results** of discharge observations, made under direction of Lieut. Col. C. R. Suter.*

[Velocities taken with double floats.]

MISSISSIPPI RIVER, AT COLUMBUS, KY.

Date.	Gauges.		Cross section.				Mean velocity per second.	Discharge per second.
	Columbus.	Local.	Area.		Mean depth.	Width.		
			Water.	Below datum.				
1879.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
Feb. 28	80.6	27.90	121,527				4.23	513,702
Mar. 1	80.1	27.40		126,495	52.49	2,410		
2	79.6	26.90						
3	79.3	26.65	118,657				3.92	465,345
4	79.2	26.53						
5	79.1	26.45						
6	79	26.30	118,183				4.06	480,356
7	79	26.35	118,298				4.06	480,254
8	79.2	26.50	118,294				4.02	475,831
9	79	26.33	118,049				3.97	468,809

Results of discharge observations, made under direction of Lieut. Col. C. R. Suter—Cont'd.

[Velocities taken with double floats.]

MISSISSIPPI RIVER, AT COLUMBUS, KY.—Continued.

Date.	Gauges.		Cross section.				Mean velocity per second.	Discharge per second.
			Area.		Mean depth.	Width.		
	Columbus.	Local.	Water.	Below datum.				
1879.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
Mar. 10	78.6	25.95	117,104				4.00	479,207
11	78.4	25.75	116,568				4.07	473,885
12	78.4	25.75	116,448				3.94	459,206
13	78.9	26.28						
14	79.7	27.03						
15	80.7	28.05	122,003				4.40	536,973
16	81.5	28.83						
17	82.2	29.50						
18	82.8	30.12	134,235	134,955	56.00	2,410	4.82	646,593
19	83.4	30.77						
20	83.9	31.27	136,180	133,435	55.45	2,410	4.95	674,540
21	84.2	31.52	137,715	134,490	56.14	2,400	4.91	675,781
22	84.4	31.73						
23	84.7	32.05						
24	85.4	32.70						
25	86.1	33.47	137,700	128,745	53.64	2,400	5.26	723,727
26	86.8	34.15	138,709	128,880	54.38	2,370	5.37	744,956
27	87.1	34.45	139,770	128,025	53.34	2,400	5.34	746,336
28	87	34.35	141,030	131,346	54.73	2,400	5.26	741,596
29	86.9	34.25	142,550	132,570	55.24	2,400	5.26	750,002
30	86.7	34.08						
31	86.4	33.75	138,285	130,230	54,26	2,400	5.29	731,795
Apr. 1	86.2	33.55						
2	86.1	33.41	142,320	133,650	55.69	2,400	5.16	733,812
3	86	33.38						
4	86.1	33.42	139,230	130,095	52.68	2,470	5.06	705,036
5	86.3	33.65						
6	86.5	33.83	138,510	129,105	52.48	2,460	5.30	734,142
7	86.5	33.87						
8	86.2	33.50	137,430	129,735	52.95	2,450	5.25	721,947
9	85.5	32.83						
10	84.9	32.27						
11	84.2	31.57	133,398	129,015	52.66	2,450	4.73	631,193
12	84	31.37		130,140	53.12	2,450		
13	84.9	32.27	138,340	132,930	54.26	2,450	5.05	698,542
14	85.6	32.90	131,085	125,010	51.02	2,450	5.09	666,737
15	85.9	33.22						
16	85.9	33.27						
17	85.9	33.25						
18	85.9	33.20						
19	85.5	32.88	134,055	127,890	52.20	2,450	4.86	652,346
20	85.2	32.53	132,930	127,350	51.98	2,450	4.98	661,560
21	85	32.32	131,080	126,315	51.98	2,430	5	655,312
22	84.3	31.63	133,785	129,555	53.10	2,440	4.72	630,814
23	83.7	31	131,220	120,045	51.44	2,450	4.96	651,027
24	82.8	30.12	125,100	125,100	51.06	2,450	4.42	553,064
25	81.7	29.05	124,380	127,125	51.89	2,450	4.18	519,974
26	80.7	28						
27	79.7	27	120,735	128,565	52.48	2,450	4.05	489,544
28	78.8	26.17	119,565	129,375	52.81	2,450	3.90	466,213
29	78.1	25.40	117,230	129,150	52.71	2,450	3.77	442,421
30	77.3	24.66	113,805	125,730	51.32	2,450	3.77	429,397
May 1	76.5	23.82	111,780	127,890	52.20	2,450	3.63	405,128
2	75.7	23.02	110,970	129,015	52.66	2,450	3.38	375,050
3	74.9	22.26						
4	74.2	21.58						
5	73.7	21						
6	72.9	20.28	100,160	124,605	50.86	2,450	2.98	298,124
7	72.3	19.67	98,855	124,200	50.69	2,450	2.97	293,340
8	71.8	19.15	99,185	127,170	51.91	2,450	2.94	291,197
9	71.4	18.70	95,895	122,400	49.96	2,450	2.77	265,231
10	71	18.37	100,250	127,350	51.98	2,450	2.58	259,006
11	70.9	18.25						
12	70.7	18.08	95,420	121,815	49.72	2,450	2.65	253,020
13	70.7	18						
14	70.7	18	96,345	124,785	50.93	2,450	2.65	255,331
15	70.5	17.88	99,549	129,690	52.93	2,450	2.74	272,524
16	70.2	17.58	96,930	128,385	52.40	2,450	2.73	264,730
17	70	17.35	97,515	129,060	52.68	2,450	2.67	260,330
18	69.9	17.25	96,400	126,585	51.67	2,450	2.63	253,491
19	69.9	17.25	96,150	124,470	50.80	2,450	2.65	254,723

Results of discharge observations, made under direction of Lieut. Col. C. R. Suter—Cont'd.

[Velocities taken with double floats.]

MISSISSIPPI RIVER, AT COLUMBUS, KY.—Continued.

Date.		Gauges.		Cross section.				Mean velocity per second.	Discharge per second.
		Columbus.	Local.	Area.		Mean depth.	Width.		
				Water.	Below datum.				
	1879.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
May	20	69.9	17.23	95,570	127,440	52.02	2,450	2.63	251,376
	21	69.8	17.15	98,100	128,745	52.55	2,450	2.63	258,068
	22	69.5	16.85	94,995	126,720	51.72	2,450	2.69	255,056
	23	69.2	16.50	94,050	126,900	51.80	2,450	2.60	244,129
	24	68.9	16.27	93,012	126,495	51.63	2,450	2.40	223,829
	25	68.9	16.25	93,150	126,000	51.43	2,450	2.47	230,321
	26	68.9	16.27	92,655	125,460	51.21	2,450	2.45	227,376
	27	69	16.38	96,480	128,925	52.62	2,450	2.51	242,066
	28	68.9	16.22	94,500	128,115	52.20	2,450	2.50	236,032
	29	69	16.32	95,400	128,430	52.42	2,450	2.50	238,353
	30	69.4	16.73	94,330	125,865	51.37	2,450	2.57	242,599
	31	70.3	17.65	.....	.....	.....	.....	.....	.....
June	1	71.2	18.57	.....	.....	.....	.....	.....	.....
	2	72	19.30	103,635	129,915	53.03	2,450	3.07	318,236
	3	72.5	19.85	104,630	128,385	52.40	2,450	3.10	323,999
	4	72.9	20.25	105,660	130,410	53.23	2,450	3.02	319,097
	5	73.4	20.73	103,410	125,775	51.34	2,450	3.19	329,867
	6	74	21.38	109,440	127,935	52.43	2,440	3.30	361,505
	7	74.3	21.62	107,955	129,375	53.02	2,440	3.22	347,723
	8	74.1	21.47	108,990	129,105	52.80	2,445	3.32	361,031
	9	74	21.35	106,020	126,405	51.81	2,440	3.30	350,174
	10	73.9	21.25	107,460	127,530	52.05	2,450	3.25	348,750
	11	73.9	21.25	108,280	129,150	52.71	2,450	3.21	347,805
	12	73.7	21.05	105,300	127,035	51.85	2,450	3.21	338,490
	13	73.4	20.70	105,930	128,970	52.64	2,450	3.17	336,014
	14	73.1	20.42	104,760	128,250	52.35	2,450	3.05	319,590
	15	73.2	20.53	104,940	128,565	52.47	2,450	3.09	324,166
	16	73.3	20.68	105,300	125,145	51.08	2,450	3.20	337,017
	17	73.3	20.62	105,210	127,800	52.16	2,450	3.11	327,580
	18	73.2	20.57	106,390	130,005	53.06	2,450	3.12	331,717
	19	73.1	20.42	104,130	127,800	52.16	2,450	3.22	335,567
	20	73.1	20.40	105,360	125,685	51.30	2,450	3.08	324,433
	21	73.3	20.63	104,680	127,895	52	2,450	3.08	322,345
	22	73.8	21.17	.....	.....	.....	.....	.....	.....
	23	74.2	21.52	105,940	127,665	52.11	2,450	3.41	361,212
	24	74.3	21.65	108,990	129,420	52.82	2,450	3.32	362,016
	25	74.1	21.45	106,190	125,730	51.32	2,450	3.35	356,154
	26	73.8	21.15	.....	.....	.....	.....	.....	.....
	27	73.4	20.77	103,770	127,485	52.03	2,450	3.17	329,280
	28	73	20.38	105,233	129,420	52.82	2,450	3.22	338,945
	29	73.5	20.83	.....	.....	.....	.....	.....	.....
	30	73.9	21.27	104,235	125,910	51.39	2,450	3.22	366,118
July	1	74.9	22.20	108,120	126,225	51.52	2,450	3.62	390,854
	2	75.7	23	109,349	.....	.....	.....	3.75	409,953

NOTE.—The zero of local gauge used by observation party was 281.81 feet above the Cairo datum plane; the readings given under "Columbus" are derived from the local gauge readings by adding 52.67 feet. Extracts from reports follow these tables.

Results of discharge observations, made under direction of Lieut. Col. C. R. Suter—Cont'd

ARKANSAS RIVER, PINE BLUFF, ARK.

Date.	Gauges.		Cross section.				Mean velocity per second.	Discharge per second.
			Area.		Mean depth.	Width.		
	Little Rock.	Local.	Water.	Below datum.				
1879.	Feet.	Feet.	Sq. ft.	Sq. ft.	Feet.	Feet.	Feet.	Cu. ft.
Feb. 9	13	19.40						
10	11.9	18.29						
11	11	17.34						
12	10.3	16.37						
13	9.5	15.64						
14	8.9	15.04						
15	8.1	14.29						
16	7.7	13.66						
17	7.1	13.23						
18	6.8	12.81						
19	6.7	12.63						
20	6.6	12.56	7,693	7,592	7.75	980	3.50	26,919
21	6.5	12.31	7,670	7,808	8.01	975	3.15	24,167
22	6.1	11.97	7,920	8,319	8.53	975	2.92	23,101
23	5.8	11.60						
24	5.5	11.21	7,861	8,035	8.24	975	2.50	19,645
25	5.2	10.62	7,555	8,991	9.22	975	2.37	17,891
26	5	10.39	7,430	9,014	9.25	975	2.42	17,979
27	4.9	10.13	7,335	9,116	9.35	975	2.35	17,261
28	4.9	9.96	7,120	9,104	9.34	975	2.28	16,282
Mar. 1	4.9	10.04	7,217	9,141	9.37	975	2.28	16,450
2	4.9	10.01						
3	4.9	9.92	7,310	9,337	9.57	975	2.24	16,392
4	4.8	9.85	7,235	9,346	9.43	990	2.25	16,245
5	4.5	9.64	6,955	9,239	9.19	1,005	2.12	14,772
6	4.3	9.36	6,600	9,142	9.67	1,008	2.19	14,470
7	4.1	9.15	6,490	9,220	9.24	998	2.08	13,509
8	3.9	8.95	6,355	9,312	9.29	1,002	2.14	13,578
9	3.8	8.77						
10	3.7	8.65	6,190	9,440	9.35	1,010	2.04	12,649
11	3.6	8.59	6,030	9,261	9.26	1,000	1.88	11,349
12	3.6	8.64	5,940	9,346	9.35	1,000	1.91	11,362
13	4	8.94	6,260	9,328	9.19	1,015	2.09	13,079
14	4.3	9.32	7,010	9,700	9.65	1,005	2.16	15,136
15	4.8	9.63	6,970	9,340	9.34	1,000	2.16	15,020
16	4.8	9.71						
17	4.6	9.68	7,070	9,308	9.26	1,005	2.22	15,676
18	4.4	9.45	7,140	9,547	9.50	1,005	2.18	15,545
19	4.5	9.59	7,140	9,486	9.44	1,005	2.29	16,333
20	5	9.91	7,395	9,418	9.37	1,005	2.28	16,841
21	4.7	9.75	7,350	9,504	9.60	990	2.25	16,578
22	4.4	9.59	7,090	9,445	9.44	1,000	2.16	15,291
23	4.2	9.34						
24	4.2	9.28	6,790	9,419	9.34	1,008	2.19	14,880
25	4.3	9.55	6,990	9,386	9.37	1,002	2.19	15,318
26	4.5	9.57	6,980	9,165	9.16	1,000	2.24	15,674
27	4	9.34	6,850	9,399	9.40	1,000	2.18	14,910
28	3.8	8.95	6,440	9,429	9.42	1,000	2.06	13,260
29	3.6	8.67	6,154	9,377	9.28	1,010	2	12,292
30	3.2	8.45						
31	3	8.22	5,740	9,399	9.31	1,010	1.79	10,284
Apr. 1	2.9	8.06	5,685	9,483	9.34	1,015	1.78	10,141
2	2.8	7.93	5,450	9,398	9.26	1,015	1.85	10,036
3	3	8.06	5,785	9,632	9.54	1,010	1.79	10,348
4	3.5	8.43	5,966	9,462	9.37	1,010	1.92	11,502
5	3.6	8.63	6,165	9,369	9.28	1,010	2	12,323
6	3.6	8.43						
7	3.1	8.27	5,820	9,399	9.31	1,010	1.96	11,422
8	3.1	8.10	5,590	9,424	9.42	1,000	1.81	10,118
9	3.2	8.29	5,705	9,565	9.47	1,010	1.86	10,583
10	4.2	9.12	6,330	9,172	9.17	1,000	2.34	14,823
11	4.5	9.52	6,900	9,307	9.31	1,000	2.17	14,951
12	4.7	9.75	7,080	9,288	9.29	1,000	2.18	15,435
13	4.5	9.66						
14	3.8	9.08	6,685	9,479	9.39	1,010	2.12	14,199
15	3.3	8.50	6,250	9,643	9.55	1,010	1.91	11,944
16	3	8.18	5,840	9,515	9.44	1,008	1.91	11,144
17	2.8	7.93	5,780	9,648	9.55	1,010	1.81	10,446
18	3.1	8.04	5,060	9,510	9.51	1,000	1.87	10,561
19	3.3	8.19	5,825	9,523	9.45	1,008	1.98	11,518
20	3	8.05						
21	2.8	7.74	5,390	9,497	9.42	1,008	1.75	9,431
22	2.5	7.55	5,270	9,585	9.54	1,005	1.73	9,130
23	2.5	7.42	5,185	9,577	9.50	1,008	1.58	8,212
24	2.3	7.26	5,080	9,600	9.55	1,010	1.72	8,760
25	2.2	7.27						

Results of discharge observations, made under direction of Lieut. Col. C. R. Suter—Cont'd.

ARKANSAS RIVER, PINE BLUFF, ARK.—Continued.

Date.	Gauges.		Cross section.				Mean velocity per second.	Discharge per second.
			Area.		Mean depth.	Width.		
	Little Rock.	Local.	Water.	Below datum.				
1879.	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*
Apr. 26	2.2	7.56	5,255	9,582	9.56	1,008	1.76	9,240
27	2.4	7.68						
28	2.5	7.85	5,395	9,454	9.36	1,010	1.77	9,524
29	3	8.32	5,855	9,548	9.45	1,010	2.01	11,756
30	5.5	11.63	8,360	9,284	9.33	995	2.72	22,797
May 1	10	15.22	13,125	9,518	9.61	990	3.45	45,268
2	10.4	15.72	13,965	9,834	9.93	990	3.46	48 358
3	10.3	15.65	13,780	9,746	9.77	998	3.43	47,265
4	10.1	15.45						
5	9.4	14.49	12,595	10,010	9.36	1,070	3.20	40,296
6	8.8	14.46	12,770	10,031	9.29	1,080	3.11	39,756
7	9.7	15.49	13,815	10,003	9.71	1,030	3.42	47,262
8	10.8	16.54						
9	11.7	17.37	16,575	10,287	9.89	1,040	3.85	63,754
10	12	17.51						
11	11.6	17						
12	10.6	15.93	14,085	9,357	8.96	1,045	3.32	46,707
13	9.3	14.63						
14	7.8	13.30						
15	6.7	12.29	10,130	9,753	9.56	1,020	2.54	25,738
16	6	11.60						
17	5.4	10.85	8,860	9,886	9.60	1,030	2.25	19,950
18	4.9	10.11						
19	4.4	9.66						
20	4.1	9.20	7,105	10,104	9.51	1,062	1.99	14,116
21	3.7	8.90						
22	3.5	8.49						
23	3.3	8.37	6,500	10,200	9.62	1,060	1.81	11,771
24	3.1	8.17	6,375	10,200	9.71	1,050	1.77	11,271
25	2.9	7.92						
26	2.7	7.65	5,860	10,178	9.70	1,050	1.75	10,227
27	2.5	7.39	5,565	10,062	9.68	1,040	1.64	9,103
28	2.3	7.19	5,295	9,961	9.58	1,040	1.62	8,555
29	2	6.96	5,350	10,265	9.87	1,040	1.56	8,338
30	1.9	6.85	4,985	10,110	9.72	1,040	1.52	7,595
31	1.7	6.72	4,870	9,951	9.57	1,040	1.46	7,133
June 1	1.6	6.63						
2	1.6	6.59	4,940	10,195	9.80	1,040	1.43	7,059
3	1.6	6.47	4,630	10,022	9.64	1,040	1.40	6,467
4	1.6	6.45	4,680	10,101	9.71	1,040	1.40	6,550
5	1.6	6.47	4,445	9,577	9.21	1,040	1.47	6,528
6	2.2	6.96	4,800	9,900	9.52	1,040	1.50	7,222
7	4.4	8.83	6,700	9,107	8.75	1,040	1.92	12,875
8	4.6	9.44						
9	4.1	8.88	6,900	9,950	9.57	1,040	2.01	13,886
10	3.2	8.16	6,150	9,970	9.50	1,040	1.86	11,435
11	2.6	7.56	5,460	9,702	9.33	1,040	1.74	9,488
12	2	7.07	5,100	9,828	9.45	1,040	1.60	8,140
13	1.8	6.68	4,714	9,792	9.42	1,040	1.48	6,981
14	1.5	6.38	4,350	9,733	9.36	1,040	1.42	6,191
15	1.4	6.16						
16	1.4	6.04	4,290	9,765	9.39	1,040	1.29	5,522
17	1.2	5.91	4,125	9,715	9.34	1,040	1.15	4,746
18	1.1	5.77	3,970	9,639	9.27	1,040	1.13	4,477
19	1	5.64	3,780	9,550	9.19	1,040	1.05	3,974
20	1	5.49	3,590	9,465	9.10	1,040	1.11	3,971
21	0.7	5.38	3,495	9,555	9.19	1,040	1.11	3,882
22	0.7	5.31						
23	0.7	5.30	3,510	9,637	9.27	1,040	1.15	4,038
24	0.7	5.30	3,510	9,574	9.21	1,040	1.15	4,035
25	0.7	5.33	3,560	9,609	9.24	1,040	1.07	3,822
26	1	5.45	3,555	9,537	9.17	1,040	1.16	4,115
27	1	5.56	3,695	9,620	9.25	1,040	1.22	4,500
28	1	5.56	3,670	9,580	9.21	1,040	1.21	4,432
29	1.2	5.68						
30	1.6	6.02	4,010	9,547	9.18	1,040	1.20	4,819
July 1	2	6.52	4,290	9,380	9.02	1,040	1.48	6,363
2	2.3	6.84	4,835	9,865	9.49	1,040	1.56	7,561
3	2.2	6.85	5,010	10,081	9.70	1,040	1.51	7,551
4	2.1	6.74	4,740	9,862	9.49	1,040	1.55	7,347
5	2	6.68	4,900	10,091	9.70	1,040	1.53	7,513
6	1.9	6.56						
7	2.4	6.83						
8	4.2	8.40						

NOTE.—Little Rock gauge one day earlier.

Results of discharge observations, made under direction of Maj. W. H. H. Benyaard, in 1879.

[Velocities taken with double floats.]

RED RIVER, ALEXANDRIA, LA.

Date.	Local gauge.	Water area.	Mean velocity per second.	Discharge per second.	Direction and force of wind.
1879.	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	
Feb. 24	35.1	13,364	2.778	37,119	Up 1.
25	35.4	13,573	2.779	37,715	Up 2.
28	35.3	13,499	2.705	36,518	Calm.
Mar. 1	35	13,294	2.730	36,296	Up 1.
3	34.6	13,014	2.733	35,566	Calm.
4	34.3	12,806	2.674	34,246	Calm.
5	33.9	12,529	2.664	33,375	Calm.
6	33.3	12,114	2.665	32,281	Up 1.
7	33	11,917	2.655	31,640	Up 1.
8	32.5	11,574	2.561	29,637	Up 1.
10	31.6	10,959	2.527	27,690	Calm.
11	31.2	10,686	2.503	26,750	Calm.
12	30.8	10,413	2.530	26,344	Across 1.
14	29.8	9,738	2.562	24,955	Calm.
15	29.3	9,401	2.435	22,893	Up 1.
18	28.7	8,948	2.625	23,486	Across 1.
19	28.5	8,815	2.500	22,040	Calm.
20	28.5	8,815	2.520	22,211	Up 2.
21	28.3	8,681	2.009	22,651	Calm.
22	27.9	8,414	2.623	22,074	Calm.
24	26.6	7,445	2.548	18,971	Calm.
25	26	7,060	2.497	17,629	Up 1.
26	25.5	6,737	2.539	17,107	Calm.
27	25	6,412	2.496	16,003	Calm.
28	24.5	6,088	2.444	14,878	Up 1.
29	24.1	5,829	2.520	14,687	Down 2.
31	23.3	5,314	2.366	12,573	Up 3.
Apr. 2	22.8	4,857	2.564	12,455	Across 2.
3	22.4	4,604	2.583	11,890	Down 2.
4	22.2	4,478	2.485	11,126	Calm.
5	21.9	4,288	2.444	10,478	Calm.
7	21.5	4,038	2.493	10,066	Down 2.
8	21.2	3,851	2.442	9,402	Calm.
9	21	3,721	2.358	8,773	Up 3.
10	20.7	3,540	2.585	9,149	Down 4.
11	20.5	3,416	2.465	8,422	Down 2.
12	20.2	3,230	2.397	7,743	Up 1.
14	20.4	3,458	2.412	8,340	Across 2.
15	20.3	3,390	2.404	8,164	Calm.
16	21.8	4,328	2.506	10,845	Calm.
18	23.9	5,662	2.720	15,408	Down 3.
19	24.6	5,932	2.684	15,919	Up 1.
23	24.6	5,932	2.608	15,476	Up 3.
26	30.8	9,563	3.448	32,973	Down 1.
28	35	12,461	3.255	40,560	Calm.
29	34.7	12,255	3.020	37,011	Calm.
30	33.7	11,561	2.889	33,400	Up 1.
May 1	32.9	11,232	2.824	31,805	Down 1
2	31.9	10,572	2.678	28,308	Up 2.
3	30.9	9,887	2.603	25,731	Up 2.
5	29.4	8,768	2.606	22,845	Calm.
6	29.4	8,768	2.762	24,218	Down 2.
7	30.6	9,681	2.866	27,749	Across 1.
8	31.4	10,229	2.832	28,967	Calm.
9	31.8	10,503	2.809	29,503	Up 1.
10	32.3	10,848	2.850	30,917	Calm.
12	33.5	12,140	2.946	35,767	Up 1.
13	33.8	12,346	2.974	36,721	Up 1.
14	34.3	12,693	3.051	38,733	Down 2.
15	34.8	13,046	3.095	40,384	Down 2.
16	35.3	13,399	3.070	41,133	Down 2.
17	35.8	13,751	3.081	42,363	Calm.
19	37	14,632	3.155	46,161	Up 1.
20	37.3	14,844	3.192	47,385	Up 2.
21	37.7	15,128	3.262	49,348	Down 2.
22	38.1	15,409	3.285	50,203	Up 2.
23	38.3	15,553	3.184	49,526	Up 2.
24	38.6	15,768	3.135	49,437	Up 1.
26	38.6	15,864	3.168	50,263	Up 1.
27	38.4	15,723	3.114	48,957	Up 1.
28	38.2	15,580	3.105	48,378	Up 1.
29	37.9	15,367	3.033	46,606	Up 2.
30	37.4	15,013	2.991	44,909	Up 1.
31	36.9	14,659	2.982	43,716	Up 2.

Results of discharge observations, made under direction of Maj. W. H. H. Benyaurd, in 1879—Continued.

[Velocities taken with double floats.]

RED RIVER, ALEXANDRIA, LA.—Continued.

Date.	Local gauge	Water area.	Mean velocity per second.	Discharge per second.	Direction and force of wind.
1879.	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	
June 4	34.4	12,762	2.828	36,088	Up 1.
5	33.7	12,277	2.802	34,394	Calm.
6	32.9	11,724	2.769	32,466	Up 2.
7	32.2	11,243	2.747	30,886	Up 2.
9	30.2	9,705	2.706	26,265	Up 1.
10	29.6	9,298	2.712	25,218	Calm.
11	28.7	8,690	2.711	23,557	Up 1.
12	27.8	8,090	2.690	21,807	Calm.
13	26.9	7,453	2.650	19,750	Up 2.
14	26.4	7,145	2.706	19,334	Up 1.
16	25.2	6,358	2.737	17,405	Down 2.
17	24.7	6,033	2.707	16,332	Calm.
18	24.1	5,646	2.599	14,673	Up 1.
19	23.7	5,388	2.603	14,027	Up 1.
20	23.2	4,979	2.582	12,858	Up 2.
21	22.7	4,660	2.556	11,910	Up 3.
23	21.9	4,153	2.630	10,921	Up 2.
24	21.6	3,964	2.662	10,554	Calm.
25	21.2	3,714	2.651	9,845	Calm.
26	20.9	3,527	2.602	9,176	Up 1.
27	20.6	3,341	2.567	8,575	Up 1.
28	20.3	3,156	2.631	8,305	Calm.
30	19.8	3,107	2.553	7,869	Variable 1.
July 1	19.5	2,923	2.581	7,544	Up 1.

NOTE 1.—Zero of this gauge is 20 feet lower than zero of standard U. S. Engineer gauge at Alexandria.

WHITE RIVER, CLARENDON, ARK.

Date.	Gauge.*	Water area.	Mean velocity per second.	Discharge per second.	Direction and force of wind.
1879.	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	
Feb. 5	22	13,671	2.489	34,025	Down 2.
6	22.3	13,832	2.466	34,113	Down 1.
7	22.6	13,965	2.665	37,208	Down 1.
8	22.8	14,072	2.700	37,990	Down 1.
11	23.3	14,339	2.748	39,405	Calm.
12	23.3	14,339	2.738	39,263	Up 1.
15	23.2	14,285	2.618	37,394	Down 1.
18	22.7	14,045	2.558	35,925	Down 1.
19	22.4	13,885	2.409	33,447	Up 1.
20	22.1	13,698	2.363	32,372	Down 2.
27	18.6	11,684	1.859	21,726	Across 1.
Mar. 3	16.6	10,627	1.764	18,741	Down 1.
4	16.1	10,364	1.689	17,503	Up 2.
5	15.6	10,101	1.690	17,075	Up 1.
12	12.9	8,461	1.656	14,009	Down 2.
15	12.8	8,409	1.657	13,934	Calm.
19	13.8	8,931	1.816	16,215	Down 2.
21	14.3	9,219	1.866	17,201	Down 2.
24	15.8	9,940	1.910	18,982	Calm.
25	15.9	9,992	1.868	18,664	Calm.
27	16	10,019	1.859	18,629	Calm.
29	15.5	9,755	1.781	17,377	Calm.
31	14.7	9,361	1.588	14,865	Across 2.
Apr. 2	14.4	9,177	1.671	15,332	Down 2.
5	14.6	9,308	1.655	15,403	Down 1.
8	15.4	10,164	1.585	16,105	Up 2.
12	16.8	10,900	1.875	20,439	Calm.
15	16.9	10,978	1.822	20,002	Down 1.
16	16.8	10,899	1.854	20,203	Down 2.
18	16.2	10,583	1.719	18,196	Down 3.
26	15.4	9,997	1.615	16,148	Calm.
28	16	10,339	1.778	18,385	Down 2.
29	16.1	10,392	1.770	18,398	Calm.
30	16.1	10,392	1.765	18,340	Calm.
May 1	16.3	10,497	1.921	20,163	Down 3.
2	16.8	10,734	1.927	20,683	Calm.
5	18.3	11,525	2.087	24,051	Variable.

*This gauge is at the same elevation as gauge of the Mississippi River Commission.

Results of discharge observations, made under direction of Maj. W. H. H. Benyaurd, in 1879—Continued.

WHITE RIVER, CLARENDON, ARK.—Continued.

Date.		Gauge.*	Water area.	Mean velocity per second.	Discharge per second.	Direction and force of wind.
1879.		*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	
May	6	18.7	11,762	2.115	24,880	Down 2.
	7	19.	11.894	2.192	26.072	Down 1.
	8	19.2	12.001	2.196	26.359	Calm.
	9	19.3	12.052	2.162	26.055	Calm.
	10	19.3	12,078	2.122	25,634	Up 2.
	13	18.5	11.643	2.001	23.295	Up 1.
	14	17.9	11.326	1.993	22,570	Calm.
	15	17.2	10,932	1.879	20.543	Down 1.
	16	16.3	10,484	1.816	19.035	Down 2.
	17	15.5	10,036	1.782	17,881	Calm.
	19	13.8	9,170	1.627	14.920	Calm.
	22	12.7	8,454	1.635	13,823	Down 1.
	23	12.6	8,377	1.630	13,657	Down 1.
	26	11.8	7,968	1.549	12.346	Up 1.
	27	11.4	7,767	1.493	11,596	Up 1.
	28	10.9	7,506	1.468	11,019	Calm.
	29	10.4	7,277	1.425	10,373	Up 1.
June	3	8.7	6,421	1.324	8,500	Down 1.
	6	8.3	6,209	1.218	7.565	Up 2.
	7	8.3	6,185	1.307	8,082	Calm.
	9	8.7	6,408	1.352	8,664	Up 1.
	10	8.8	6,434	1.338	8,609	Up 1.
	12	8.6	6,358	1.291	8,208	Calm.
	13	8.4	6,259	1.284	8,036	Calm.
	16	7.7	5,913	1.212	7.167	Down 1.
	18	7.2	5.644	1.219	6,879	Down 1.
	19	7.	5,571	1.191	6.635	Down 2.
	20	6.8	5,474	1.089	5,962	Up 2.

* This gauge is at the same elevation as gauge of the Mississippi River Commission.

[Extracts from report of Mr. N. W. Eayrs, assistant to Maj. C. R. Suter, dated July, 1879.]

COLUMBUS, KY.

* * * * * * *

The observations were confined to floats run at mid-depth only. The floats used for subsurface floats were tin cylinders 8 inches high, 8 inches in diameter, with an air space triangular in section, the base being at the top of the float and the vertex at the center of the length of the float. The float was ballasted with a band of lead at the bottom. The surface float was a tin ellipsoid. The two floats were connected by a fine wire, about 0.017 inch in diameter. * * *

The starting range, so called, was divided into spaces of 100 feet each, across the river, and angles at the lower station of the discharge sections, corresponding to each of these 100 feet intervals, were turned off in succession as the successive floats were placed in the water. * * * An observation, therefore, was considered satisfactory if the position of the lower float fell between these limits (four-tenths and six-tenths depths) in crossing the discharge section. The discharge section was sounded at least once a week and often twice a week. * * *

Datum line taken at 30 feet on the local gauge as tabulated.

PINE BLUFF, ARK.

The datum line was taken at 12 feet on the local gauge as tabulated.

[Extracts from report of Mr. H. B. Herr, assistant to Maj. W. H. H. Benyaurd, dated October 20, 1879.]

ALEXANDRIA, LA.

[The methods employed at Alexandria and Clarendon are stated to be similar to those of Hampton Landing. The latter have been described in Report of Chief of Engineers, 1887, p. 2701.]

This station was on a straight reach of the river, about 1 mile below Alexandria. Banks were both high and permanent, and the conditions generally were very favorable. * * *

Zero of water gauge at station was 20 feet below zero of United States engineer gauge at Alexandria, 55.853 feet below the United States bench mark at Alexandria (the top of the most easterly star on top of the iron sill at west door on front of the Exchange Hotel building). * * *

CLARENDON, ARK.

About 1 mile below Clarendon a high bank was found on the east side, and the distance (nearly 4 miles) across bottom lands to high bluffs on opposite side was, according to pilots and others, less than at any point below. Other features being favorable also, this site was adopted for location of discharge section. * * *

The water gauge at station had its zero 38.68 feet below top of south end of stone sill * at east door of court-house at Clarendon. * * *

To determine discharge during stages higher than about 18 feet on the gauge it was necessary to take into consideration the overflow on bottom land west of the ordinary channel. That this might be accomplished a line was cut through timber and cane to bluffs beyond. A plan and profile of a line through this cut is shown on plate herewith. Although much timber and other vegetation caused a very low velocity in water passing over bottom land, the distance on section was so great in comparison with that across ordinary channel that for higher stages it could not be neglected.†

Floats used were somewhat smaller than those described. The third form was adopted after the others had been used up.

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*This is B. M. No. 1 (Benyaurd, 1879).

†The table does not include discharge of Rockrow Bayou, which was only 381 cubic feet per second at its maximum, May 9.

Results of discharge observations, 1892.

[Field notes received at Secretary's office April 21, 1894. Observations made under direction of Capt. S. W. Roessler, by Assistant Engineer William Gerig.]

MISSISSIPPI RIVER, MEMPHIS, TENN.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge—		Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
				Area.		Depth.											
	Memphis. *	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.			Per second.	Over bank per second.				
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
Oct. 25	1.9	.....	0.0	71,471	.....	43.8	.....	83.0	1,631	.....	1.528	109,202	.....	.....	11	27	VI—Slight.

* U. S. Engineer gauge zero is 203.97 feet above the Cairo datum plane.

The discharge section is stated to be at the same place as the high-water section of 1891, which was about 3,500 feet above the Memphis bridge.

Price meter No. 34 used with rating of September 23, 1891, the low velocity equation being $y=4.1370\,x-0.0416$, in which y=velocity in feet per second, and x=registrations per second. Meter was run at six-tenths depth for two minutes at each station.

WHITE RIVER, CLARENDON, ARK.

May 19	*28.50	.....	+0.2	18,062	20,931	28.0	28.7	44.0	646	.....	2.792	50,425	54,087	105,412	9	40	Calm.
20	28.90	.....	+ .4	18 500	21,094	28.6	28.9	42.0	646	+163	2.962	54,792	†56,290	111,082	9	42	Rain.
21	29.30	.....	+ .4	18,614	20,936	28.7	28.7	42.5	648	—158	3.306	61,531	57,593	119,124	12	42	Calm.
23	30.37	.....	+ .6	19,439	21,116	26.7	28.9	43.0	728	+180	3.392	65,935	75,758	141,693	13	45	Do.
24	31.10	.....	+ .8	19,062	21,107	27.4	28.9	44.0	728	— 0	3.554	70,946	84,073	155,019	13	46	VI—Strong.
25	31.80	.....	+ .6	20,665	21,300	28.3	29.2	44.0	730	+193	3.916	80,921	90,141	171,062	13	46	VI—Mild.
26	32.30	.....	+ .4	20,898	21,168	28.6	29.0	45.0	730	—122	3.899	81,471	90,886	172,357	13	47	XII.
27	32.57	.....	+ .3	21,118	21,191	28.9	29.0	45.5	730	+ 23	3.733	78,831	90,946	169,777	14	49	Calm.
28	32.67	.....	.0	21,288	21,288	29.2	29.2	45.0	730	+ 97	3.799	80,879	92,024	172,903	13	48	VI—Strong.

* The Mississippi River Commission gauge readings at Clarendon are tabulated. The datum line is taken on this gauge at 32.67 feet for computing datum areas, as observed May 28, 1892.

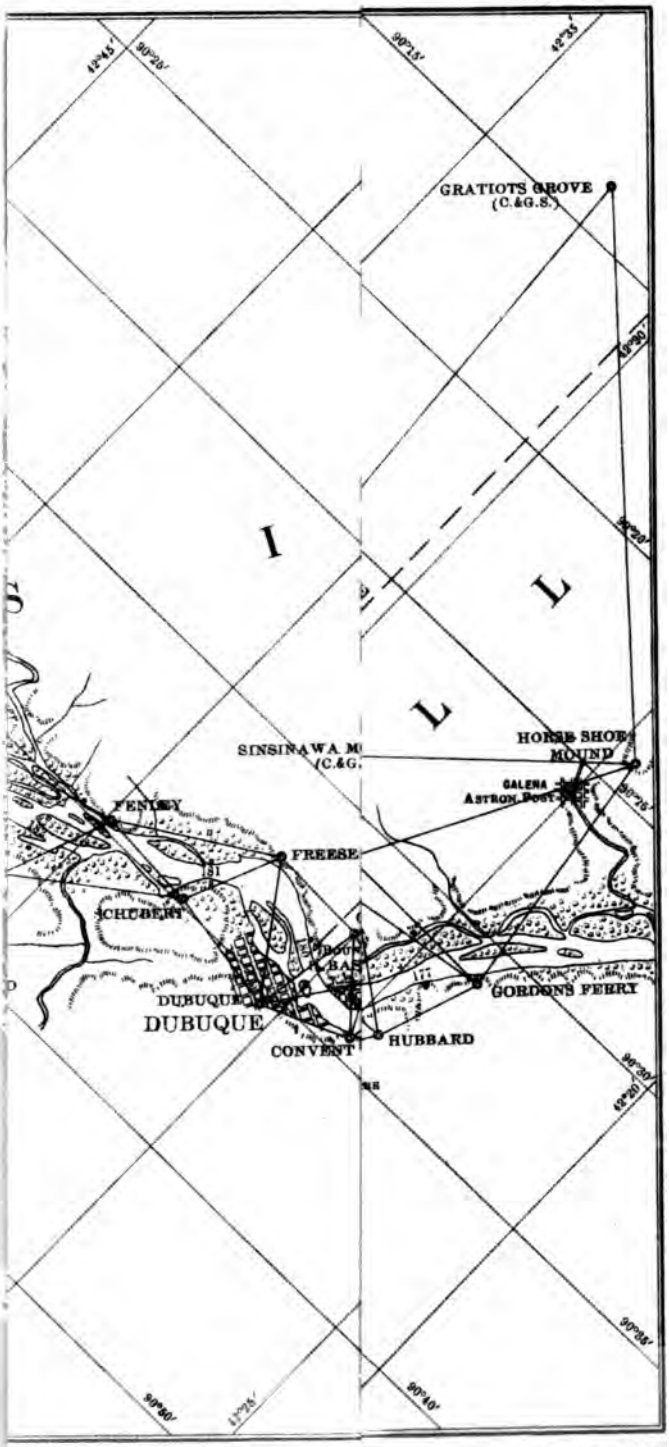
† Interpolated between 19th and 21st.

Area of bank discharge May 19 was 67,270 square feet, and width was 15,774 feet. The area increased to 131,065 square feet on May 28, the width remaining about the same. The observations were made along the St. Louis Southwestern Railway, formerly the St. Louis, Arkansas and Texas Railway. See map herewith. Meter was run at six-tenths depth from a skiff which was made fast to railroad bridge, or the trestle. At a few places floats were used (for bank discharge).

Price meter No. 34 was used with rating of September 23, 1891, taking the high velocity rating, the equation being $y=3.7805\,x+0.212$, for the river discharge; and the low velocity rating, the same as given herewith for Memphis, for the overbank discharge.

The table gives only number of stations for river proper. The number of soundings overbank was from 180 to 210, and the number of velocity stations was from 24 to 66.

PLATE I.



Eng 53 3

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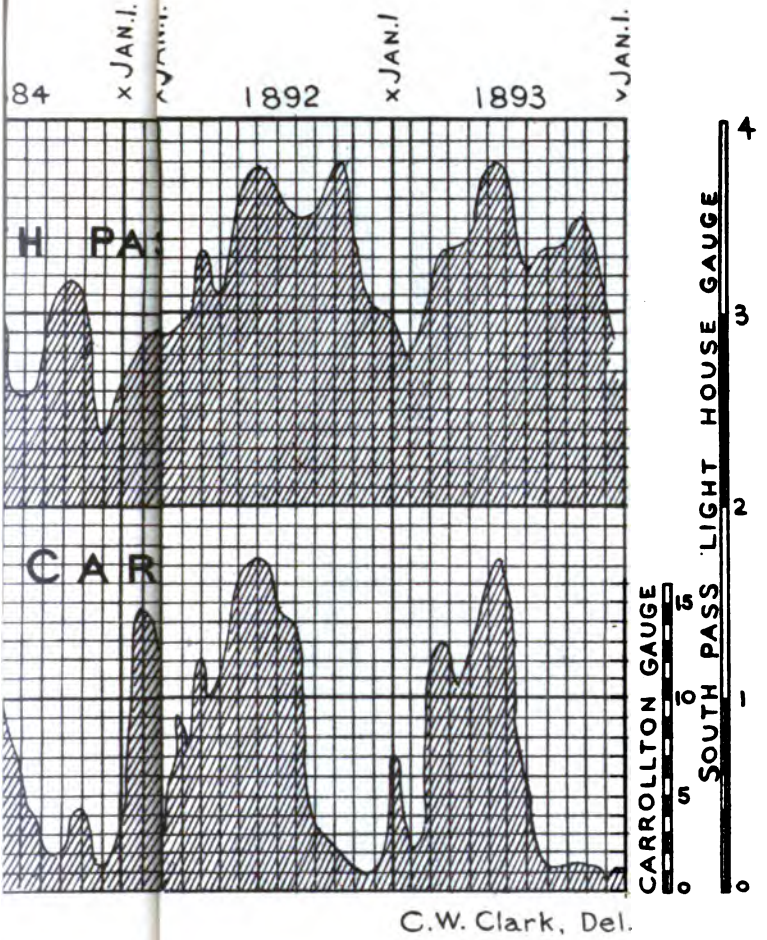


C.W. Clark, Del.

OF SOU
CARROL
JAN.1 18

Eng 53 3

J.A.C

PLATE 3

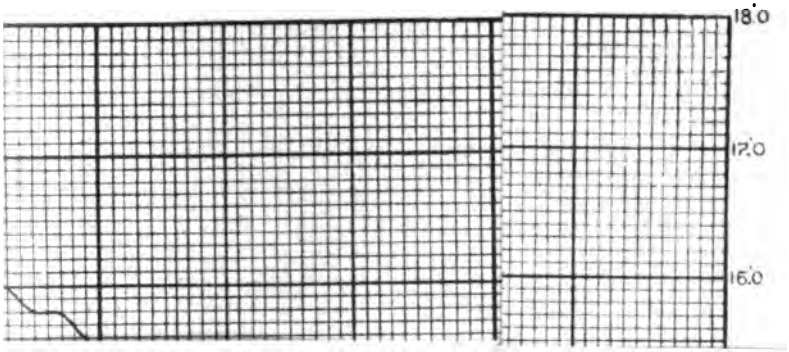
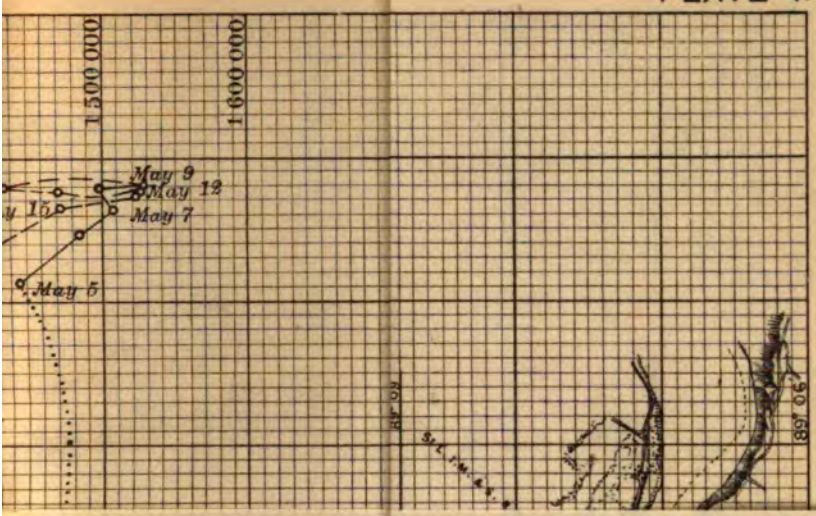


PLATE 4.



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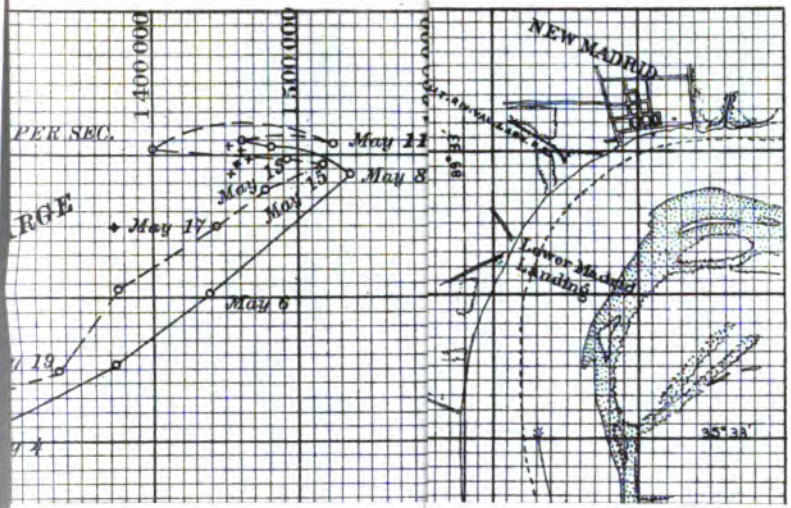

1,400,000
1,500,000
PER SEC.
RGE
May 11
May 8
May 15
May 15
May 17
May 6
NEW MADRID
Lower Madrid Landing
35° 38'

PLATE 6

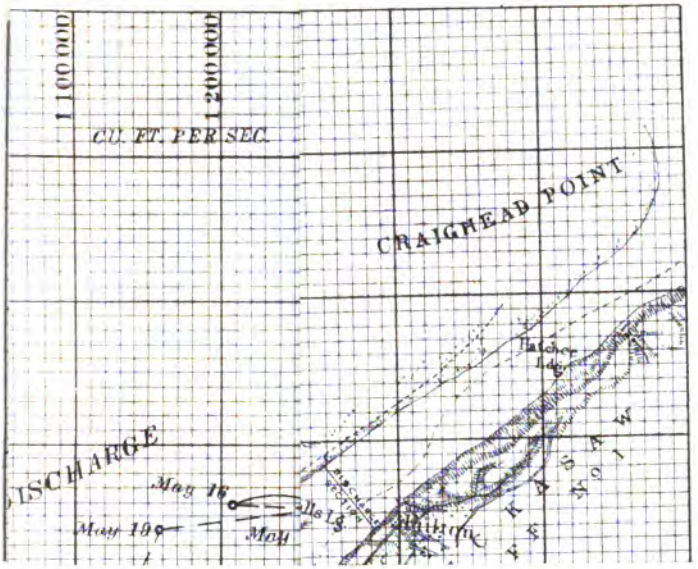

1,100,000
1,200,000
CU. FT. PER SEC.
CRAIGHEAD POINT
DISCHARGE
May 16
May 19
May 13
May
Lake
Lake
Kansas
Kansas

PLATE 7.

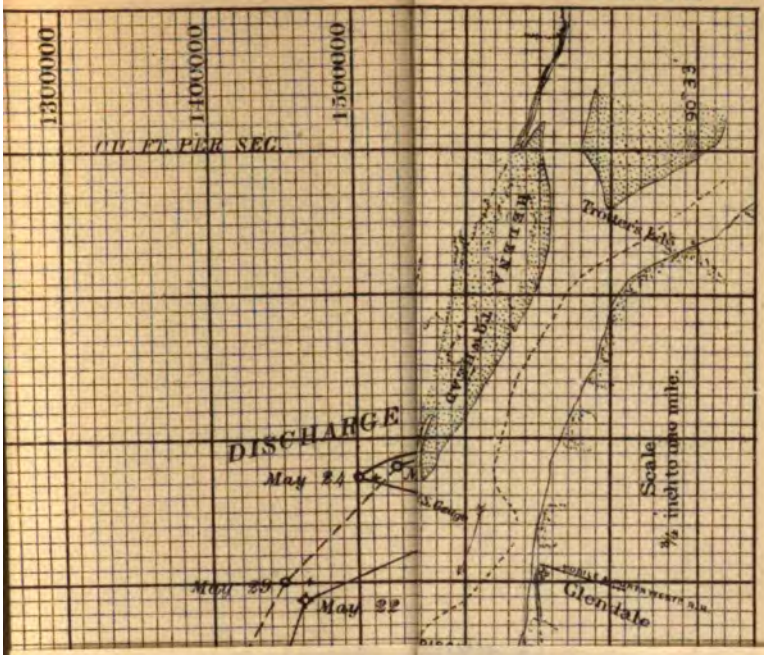
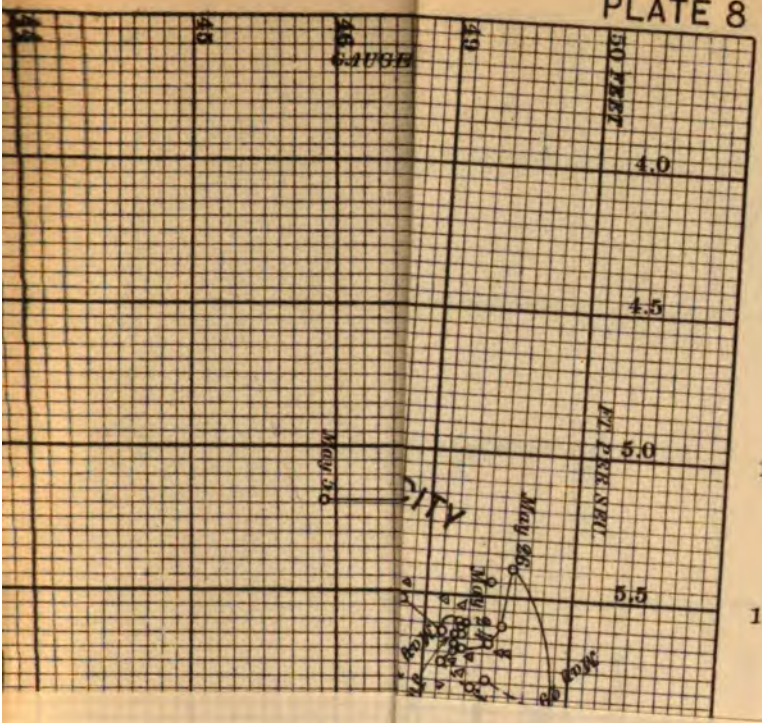
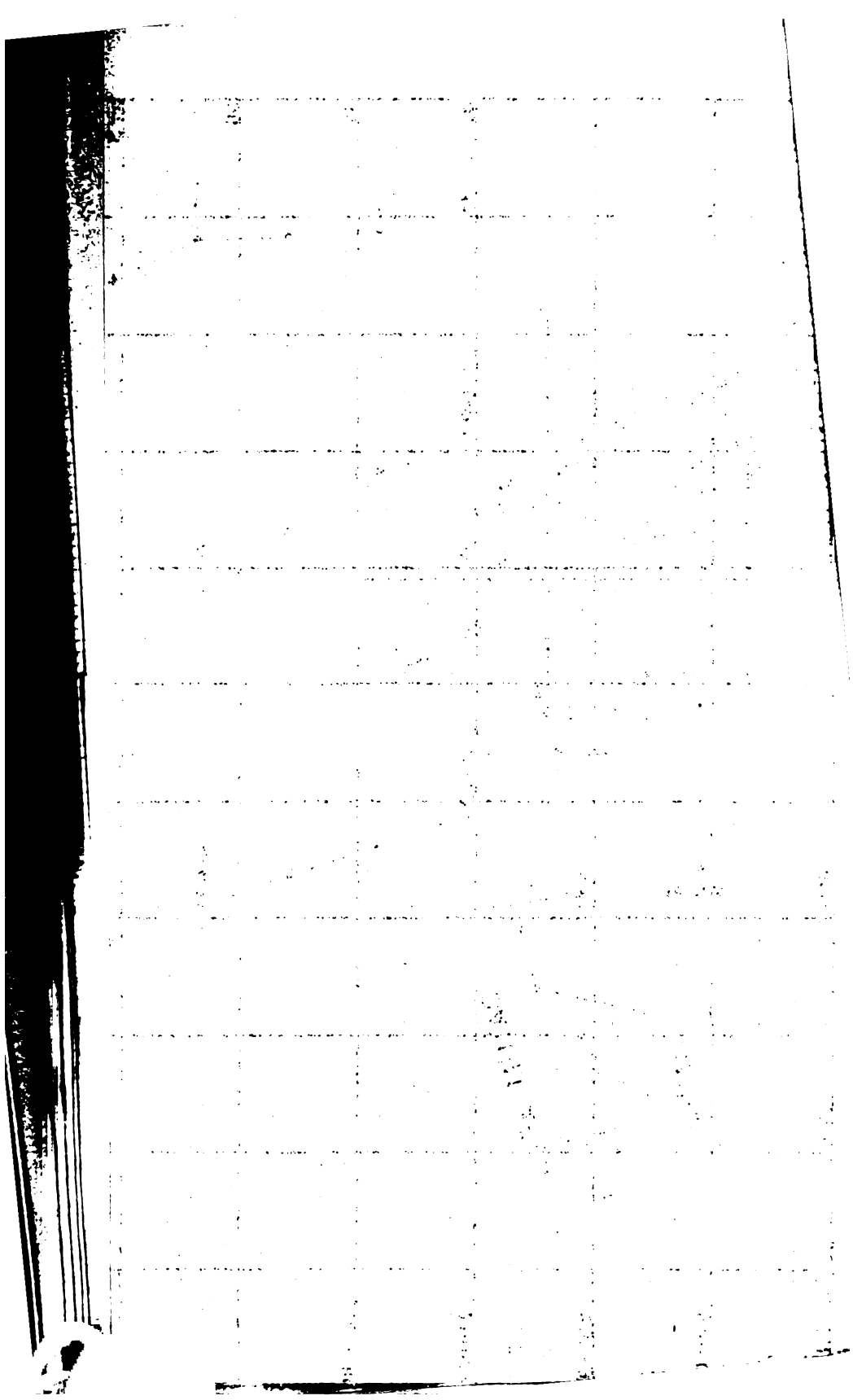

1300000
1400000
1500000
CU. FT. PER SEC.
DISCHARGE
May 24
May 25
May 22
Scale
½ inch to one mile.
Glendale

PLATE 8





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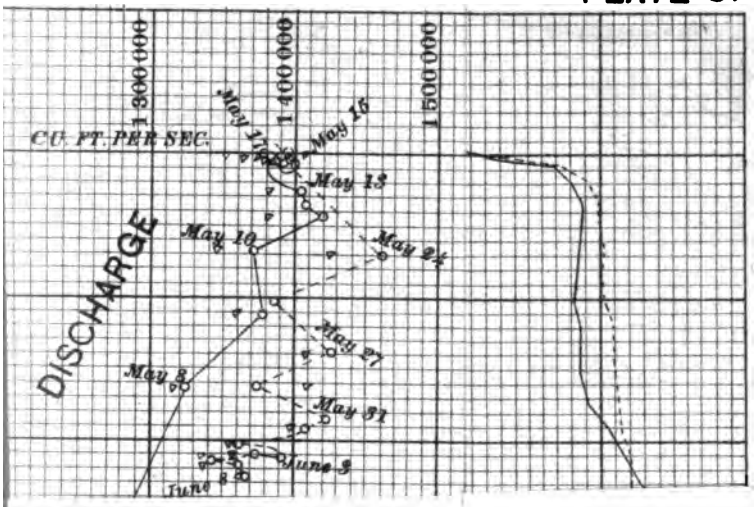

1300000
1400000
1500000
CU. FT. PER SEC.
DISCHARGE
May 11
May 12
May 13
May 15
May 10
May 24
May 27
May 8
May 31
June 3
June 8

PLATE 10.

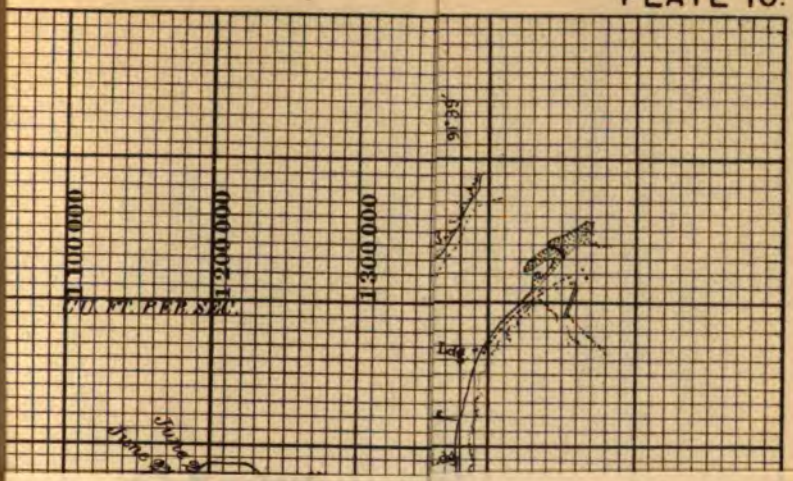


PLATE II.

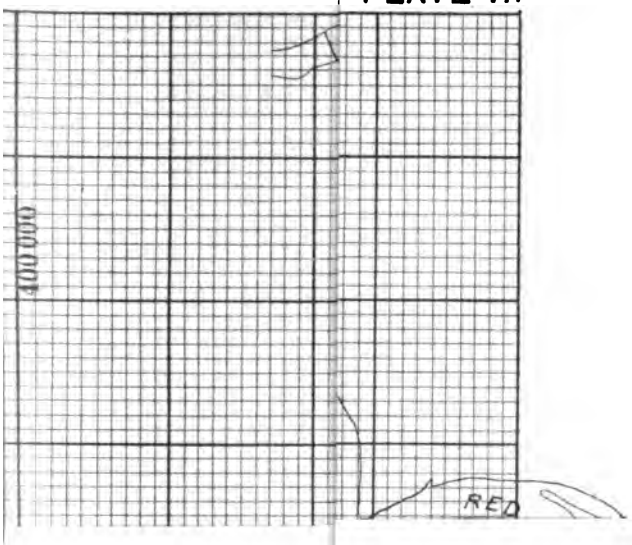
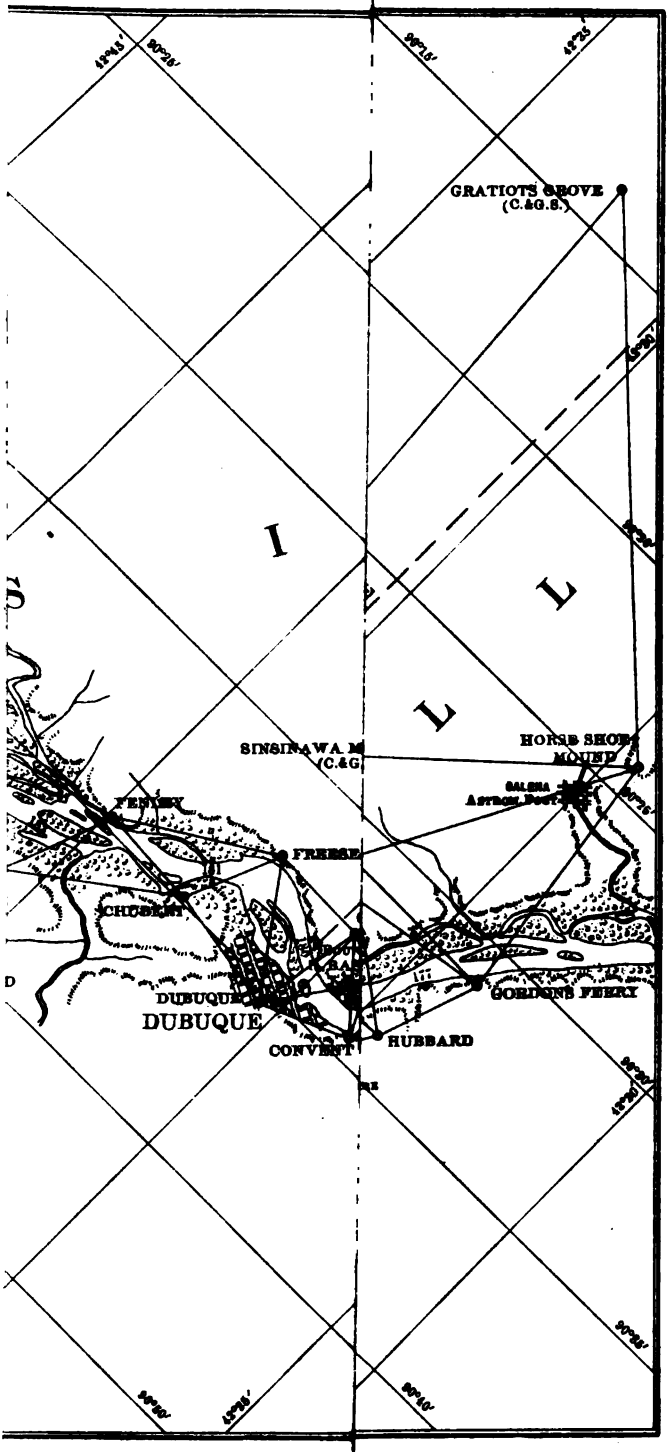


PLATE I.



Eng 58 8

APPENDIX 2.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1894.

GENERAL: I have the honor to submit the following report of operations in the First and Second Districts for the period May 31, 1893, to May 31, 1894:

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND NO. 40, 220 MILES).

Columbus, Ky., 21 miles below Cairo.—The work of improvement at this point consists of five spur dikes of brush and stone, built in 1889 and 1890, to protect about 2,200 feet of bank in front of the town, which was threatening to cave. The purpose for which they were constructed has been accomplished. A small amount of caving has been noticed in the unprotected intervals between Dikes 3 and 4, and 4 and 5, above low water, slightly undermining the edges of the foundation mattresses, but appears not to have developed sufficiently, as yet, to seriously threaten the stability of the spurs. No further work is at present deemed necessary.

Hickman, Ky., 36 miles below Cairo.—The work of improvement consists of a continuous mattress of brush and stone 1,000 feet long, placed in 1890 to stop the caving of the bank in front of the town. The protection above low water was strengthened in 1892 by placing upon it a layer of riprap stone 10 inches thick, and was extended downstream by a new mattress to cover and protect a pocket which had been scoured out by the flood of that year. The purpose for which the revetment was constructed has been accomplished, and no additional work is thought to be necessary at the present time to accomplish the object of the Congressional appropriations under which the improvement was undertaken. The revetment appears to be uninjured and practically in the same condition as at the time of the last annual report.

New Madrid, Mo., 71 miles below Cairo.—The river and harbor act of July 13, 1892, contained a special appropriation of $25,000 for the improvement of this point, and by resolution of the Commission, as approved by the Secretary of War, this sum was to be expended in revetting the bank at the upstream portion of the town, beginning at Dry Slough and extending downstream as far as the funds would permit.

The execution of this work was made the first task in channel operations for 1893. The stone required was stored on the bank during the previous high water and the preliminary operations for the construction of the mattress were commenced July 21, and continued till the completion of the revetment on the last day of the following month.

As completed, this revetment consists, first, of a subaqueous mattress of brush and stone of the fascine type, 900 feet long and 250 feet wide; second, of auxiliary mattresses to connect the main mattress with the edge of the shore paving at the water line, and, third, of a shore paving consisting of a layer of quarry spalls 4 inches in thickness, on top of which was placed a layer of riprap stone, extending from the water line up the graded bank to the level of the 27-foot stage. Preparatory to laying the shore paving, 360 linear feet of the upper bank at the upstream end of the mattress was graded to a slope of 1 on 3. Below this no grading was necessary, as the natural bank presented a uniform slope of about this inclination, on which no dressing was required.

The revetment as constructed here presents no new features not already familiar to the Commission, except the subaqueous mattress, which was the first experiment on a large scale of the construction of a mattress of brush fascines, which the Commission had authorized me to use experimentally during the season of 1893 in lieu of the old woven type of mattress, which had been used up to that time. As a full description of this new form of mattress will be given in another portion of this report, no further allusion to it is necessary in this connection than to say that, owing to our want of experience in this form of construction, the cost per linear foot of mattress and of bank protected was necessarily higher than the cost of similar work done in Plum Point Reach later in the season, after the details of the new type of mattress had been fully developed.

The cost of the work was as follows:

	Per linear foot.
River mattress	$15.62
Connecting mattress	2.32
Bank paving	7.58
Superintendence, care of plant, etc	2.26
Total	27.78

Soundings were taken over the mattress in September, 1893, and again along the same range in May, 1894. A comparison of the latter with the former show that there has been no scour at the river edge of the mattress in the interval, and no appreciable settling at points nearer the shore; also that there has been but little caving for several hundred feet above and below the ends of the mattress.

An extension of this work downstream far enough to protect the whole town of New Madrid against further encroachments by the river is contemplated when funds therefor are appropriated by Congress.

For further details see report of Mr. William Gerig, the assistant in local charge.

Plum Point Reach, 147-186 miles below Cairo.—Under this title works of improvement have been executed at various localities between Daniels Point and Craighead Point, Arkansas, a distance by river of about 20 miles. They are fully described in previous reports.

During the current fiscal year the improvement of the reach has been continued by the extension of the Ashport Bend revetment, by the construction of new revetment at Bullerton Towhead, by the repair of a breach in the revetment of Fletcher's Bend, and the construction of a solid brush and stone dam in Gold Dust Chute.

The delivery of stone was commenced in April, 1893. A formal contract was entered into with Mr. Fred Hartweg, of Cincinnati, Ohio, for a supply of 25,000 cubic yards of riprap stone, delivered on barges at Plumb Point Reach, and under this contract a total of 29,174 cubic yards of riprap and 5,979 cubic yards of spalls were received during the season. The prices paid were, for limestone riprap, $1.69 for small size and $1.59 for large size; for sandstone, large size, $1.54, small size, $1.64, and for spalls, $1.20 per cubic yard for sandstone and $1.30 for limestone. An additional supply of 21,994 cubic yards riprap and 1,940 cubic yards of spalls was obtained from Apple Creek quarries under an open-market purchase and towed by Government steamers and barges. This stone cost 62½ cents per cubic yard loaded on barges at the quarry, and the towage, including only pay and subsistence of crews and fuel bills, was 30.88 cents per cubic yard. The total quantity received was 59,188 cubic yards, which, together with 17,169 cubic yards left over from last year, was distributed as follows:

Ashport revetment	37,736
Bullerton revetment	17,808
Fletcher's revetment	2,338
Gold Dust Dam	18,693

Leaving a balance of only 304 cubic yards unused at the end of the season.

The brush and poles were obtained by open-market purchase from Messrs. Hunter & Frey, of Memphis, Tenn. For brush obtained above Memphis $1.05 per cord was paid. For brush obtained below Memphis the price was 3 cents less per cord. Poles were $1.50 per cord.

Other materials, as wire strand, wire, etc., were purchased in open market, competition being invited when practicable.

The towing service was performed at first by the steamers *Osceola* and *Vidalia*. Later in the season, when the brush supply above Plum Point was nearly exhausted and the upstream towage had become very heavy, the steamer *Osceola* was returned to the third district and the *Minnetonka* put into commission.

The forces at Plum Point were divided into three separate parties with separate offices and organizations, each under the immediate charge of an employé of the grade of assistant engineer and all under the general control of the chief assistant, Mr William M. Rees.

Revetment Ashport Bend.—The revetment was commenced in 1891 at the upper limit of caving and 3,250 linear feet was built that year. In 1892 the revetment was extended downstream 8,500 feet, leaving 4,000 feet of bank at the lower end of the bend still to be protected. Soundings were taken over the revetment along ranges 100 feet apart during the low water of 1892 and a number of the same sections were again sounded at low water in August of 1893. The soundings were plotted in such a way as to show by inspection the settling which had taken place in the subaqueous mattresses during the interval and were discussed by me at length in a special report, dated September 27, 1893. Only a brief reference will be made to them here.

Beginning at the upper end, the mattresses for a distance of 3,200 feet were 200 feet wide, and the sections indicated no appreciable change in their position. For the next 1,100 feet the mattresses were also 200 feet wide, and though some settling was noted it was not of sufficient extent to throw any doubt on the stability of the mat. For the next 1,300 feet the mat was 240 feet wide. The bank here, known as Mud Point, was composed of soft and "quick" material. Settling was anticipated, but the sections do not differ from each other enough to indicate any appreciable change in the slope or position of the mattress. For a distance of 700 feet farther downstream the mattress was 200 feet wide and was undermined by scour at the edge along its whole length. The settling was greatest along the lower 400 feet and

extended across the whole width of mat. A break occurred here in the shore paving. For the next 1,400 feet the mattress was 240 feet wide. It was undermined by scour at its edge along its whole length, the average scour being 20 feet in depth. The average undermining inshore was 86 feet in width. The next mat, 900 feet long, was 200 feet wide. The average scour at its river edge was 40 feet deep and the mat was undermined for an average width of 152 feet. For a distance of 500 feet the settling extended over the whole width of mattress and opposite to it a break occurred in the shore paving. For a distance of 200 feet below this break the mat, in settling, slid out from the paving, leaving a strip of earth about 5 feet wide exposed to the action of the current. For a distance of 1,740 feet below this the mattress was 240 feet wide. The scour at the upstream end was 27 feet deep. From this point downstream the scour increased to a depth of 50 feet at the lower end, where the depth of water was increased from 50 to 100 feet below low water. For a length of 400 feet at its downstream end the mattress settled over its whole width, the average displacement vertically being 37 feet. The next and last mattress was 1,100 feet long and 200 feet wide. The mattress had settled over its whole width and length, and the shore paving was completely destroyed. The average settling of the mattress was 32 feet, and the greatest at the channel edge was 50 feet. For the reasons given at length in my report of September 27, 1893, it was not deemed safe to repair the lower 1,400 feet of the 1892–'93 revetment by anything less than a complete new bank protection, including river mattress 300 feet wide.

The plan for the season's work besides the minor repairs to the shore paving where local injuries had occurred, was therefore to renew the lower 1,400 feet of the previous year's work by new and wider mattress and to extend the revetment downstream by like matresses, as far as the funds would go. Under this plan the season's work included the minor repairs above noted and the construction of 5,580 feet of complete bank protection, beginning 1,600 feet above the foot of the previous year's work at station 99 + 40 and extending to a point 1,350 feet above the head of the Gold Dust dikes at Gold Dust Landing.

The work was commenced September 6, 1893, and completed January 22, 1894.

The season's work included the construction of 6 matresses, 658, 825, 913, 1,095, 1,119, 1,125 feet long, respectively. All were of the fascine type and 300 feet wide. Their cost was $6.282 per square, or $18.846 per linear foot. Auxiliary mats were used to connect the edge of the river mats with the edge of the shore paving at the water line. Of these 3,173 linear feet, aggregating 1,755.25 squares, were constructed and all of the fascine type except 940 feet, which were of the old woven type of mattress. The cost of the fascine connecting mats was $11.85 and of the woven type $8.17 per square. The bank was graded after the mats were sunk to a slope of 1 on 3. No special difficulties were encountered in this work. The grading included the sloping of 5,690 linear feet of bank and the movement of 154,795 cubic yards of dirt at a cost of 3.8 cents per cubic yard. The shore paving along the upper two mats was carried from the water line to the level of 20 feet stage of river. Along the next three mats it was carried up to 17 feet, and along the last mat to 15 feet stage. The paving consisted of a layer of spalls 4 inches in thickness and upon this a layer of riprap 8 inches in thickness at the water line and 4 inches in thickness at the top. The total linear feet of bank paved was 5,580 feet, and included 34,330 square yards of paving, costing 91 cents per square yard, or $5.59 per linear foot. The repairs to the breaks in the shore paving in the 1892–'93 work included 539.5 squares of connecting mats, 540 linear feet of bank graded, 1,282 linear feet, or 7,265 square yards of paving. The total cost of the season's work was $181,319.40.

Of the four spur pile dikes constructed in the pockets at Mud Point during the season of 1892–'93, to break the force of the eddies in that vicinity, two were left incomplete, and these were completed between March 11 and 25, 1893. Although the dikes do not extend as far outstream as was originally intended, they have served the purpose of their construction and no addition to their length is required.

As before stated, the bank at Mud Point, from the manner in which it used to cave, was evidently of a very treacherous formation, and it was thought to be one of those banks which it would be very difficult, if not impossible, to keep from caving by any form of revetment we might place upon it. Anticipating that a breach in the mattress might occur at this point, and in order to throw as much light as possible on the reason for the breach in the event of its occurrence, four borings were made in the vicinity to ascertain the composition of the bank. One of the borings was stopped at 110 feet depth below the top of the bank. The other three were, respectively, 164, 166, and 168 feet in depth. The results have been plotted graphically in the usual way.

The freshets of the past season have caused one break in the shore paving of this revetment. The break begins at the upper end of last season's work at station 99 + 40, and extends upstream about 450 feet to section 95. To ascertain the exact situation here, and also to note how much the mats over the whole bend have settled since the last surveys, soundings were made over the whole revetment in April, 1894.

The soundings in the vicinity of the break indicate not only a destruction of the shore paving, but a considerable settlement of the adjacent river mat over its whole width. At section 99 + 40, where the break begins, the river mat shows no settling except for a width of about 25 feet at the shore edge. One hundred and forty feet above this, at section 98, which lies over the old mattress, the mattress has settled over its whole width, the settling being greatest near its shore edge and least at the river edge. At section 97 the settling extends also over the whole width of mattress, being about 30 feet at the shore edge, 25 feet at the channel edge, and 10 feet at the middle point. At section 96 there has been an average settling of about 10 feet over the outer third of the mattress, and of about 20 feet near the shore, and none between. On section 95 the outer half of the mattress has been undermined for half its width at the channel edge, but no settling is noted over the shore half. The bank is located at what was once the mouth or source of an old but small chute, leading to a lake a half a mile or more back of the bank at this point. If, as is not improbable, the chute through its subsurface strata serves as a drain to the lake when the level of the river is below the level of the lake, the cause of the break becomes evident. The water of the lake returning to the river through a subsurface stratum of porous material, has transported through the mattress the material upon which it rests, gradually allowing it to settle and eventually to separate so far from its shore paving as to allow the current to undermine the shore paving along the uncovered space between it and the edge of the mattress.

The remainder of the work is without rupture or dangerous settling in any point. The soundings of April, 1894, over the new fascine mattresses indicate a settling at three points that appear to reflect upon the ability of these mats to prevent the transport of material through them by the return flow at falling river from a saturated bank. At station 114 a settling of 5 to 8 feet has occurred over the whole width of the mattress. At station 128 a like settling, but of greater extent, is noted, being 10 feet at the shore edge, 5 feet feet at the middle, and 12 feet at the river edge of the mattress. At stations 131 and 132 there appears to have been settling over the shore half of the mattress and 100 feet farther downstream, at section 133, the middle of the mat has seetled for a width of 50 feet. With these exceptions the settling indicated by the later soundings do not, as yet at least, show any marked weakness or want of stability in the revetment.

For further details see report of Assistant Engineer Aug. J. Nolty.

Revetment, Bullerton Tow-Head.—The original revetment of the channel face of this tow-head was built in 1882–'84, and was 10,000 feet long. For some years after its construction it was protected by an outlying sand bar from any considerable attack of the current. In 1892 this bar was washed away, and the attack of the flood of 1893 upon the revetment breached it in a number of points. The mattresses here were among the first constructed by the Mississippi River Commission and had a width of only 100 feet. Later experience having shown this width to be much too small, the Commission decided to renew the entire revetment of the tow-head with mattresses of proper width, and $100,000 was allotted to begin this work, to be expended in the working season of 1893–'94.

The plan was to begin the revetment about 400 feet above the head of the tow-head where the mattresses of 1890 end and to extend it downstream as far as the funds would go. Work was commenced September 21 and completed January 15, 1894. Four mattresses were here constructed during the season, all 250 feet wide. The first three were respectively 1,243, 1,044, and 1,203 feet in length, and were constructed with the fascines normal to the bank. The last mat was 588 feet long and was constructed with the fascines parallel to the bank. A full description of them will be given hereafter. Their average cost was $5.96 per square. Of connecting mats only 211 squares were constructed. These were in two small pockets near the head of the tow-head, and were made like the old-style woven mattress. The original plan was not to grade the bank where the slope was not greater than 1 on 2 or where the shore revetment of the old work appeared to be uninjured, but it was afterwards decided to grade the whole of it to a slope of 1 on 3, the old stone paving being recovered and used again in the new paving. The paving extended from the edge of the mattress to a level about 6 feet below the top of the bank. It consisted of a layer of spalls 3 to 4 inches thick, and on top of this a layer of riprap stone. The thickness of the paving was 8 inches at the top and 10 to 12 inches at the bottom. The average net cost per square of paving was $8.50. To protect the head of the tow-head a mat 90 feet wide, extending 180 feet along the tow-head, was built in the chute just behind an old crib dam, and 65 feet of the dam itself was raised above the middle portion for the purpose of maintaining the thalweg in the chute at a safe distance from the bank. The bank along the above mattress was graded and paved. The total expenditure on account of this work was $88,307.18, and the cost per linear foot of bank protection was $21.98. For further details see report of Assistant Engineer E. L. Cooley.

The old revetment along the lower end of Osceola Bar and along the whole channel face of Bullerton, about 14,500 feet long, was sounded along sections 100 feet apart in September, 1893. Similar sections were taken over the new mattress in December, 1893, and the sections of September, 1893, were repeated over the whole length of the revetment in April of 1894. The soundings of April, 1894, compared with those of September and December, 1893, show but little settling in the mattress along Osceola Bar and along the mattress placed last year, but indicate a considerable displacement and further destruction of the old matresses at the lower end of Bullerton Bar.

Dam in Gold Dust Chute.—The closure of the chute behind Elmot Island was included in the earliest projects of the Commission for the improvement of Plum Point Reach. The first effort to close it was the construction of the Gold Dust dikes at the head of the chute, beginning in 1882. These dikes caused heavy deposits, but did not completely close it. To aid in increasing the deposits still further two cross-pile dikes were constructed in 1889–'90 across the chutes of Elmot and Island 30, which are the two channels through which Gold Dust Chute returns its flow to the river. These dikes were raised to extreme high-water level. Both were broken through in 1890 by accumulated drift, and were repaired the same year. They were again breached in 1891, and about one-half of each dike was lost. No repairs have been made since, but even in their broken condition the dikes have materially checked the current and caused new deposits in the bed of the chute above and below them.

In 1892 the Commission approved a project for the construction of a solid dam of brush and stone, 16 feet high above low water, across Gold Dust Chute at its narrowest point. The location is shown on Sheet I, and its construction was to be as follows: A sill or foundation mattress of brush and stone 50 feet wide and 2½ feet thick was to be laid on the bed of the chute from bank to bank. If constructed afloat, the mattresses for the sill were to be made and sunk in lengths of 100 feet. In construction, each mattress was to consist of two layers of brush at right angles, with a top and bottom grillage of longitudinal and transverse poles 8 feet apart between rows, the whole compacted and bound together by wire lashings connecting the top and bottom grillages. If constructed in place, the sill was to be made continuous from bank to bank. Upon this sill mattress as foundation the dam was to be raised to the established grade by mattress of like construction and dimensions, the mattresses of each layer or tier being placed 8 feet farther upstream than those in the layer next below. An apron 50 feet wide and of similar construction was to be built below the dam to receive the overfall. At each end of the dam the bank was to be graded to a slope of 1 on 3 and revetted for a distance of 100 feet above the dam and 300 feet below it. After the inspection of the dam by the Commission in November, 1893, the project was modified, by authorizing an increase in the width of the apron mat from 50 feet to 75 feet for a distance of 1,000 feet near the Tennessee shore and 400 feet on the Elmot Bar end. This project was executed during the fall of 1893, work commencing August 9 and ending with the completion of the dam, January 3, 1894. When the original project was prepared the depth of the deepest portions of the chute near the banks was about 2 feet below zero on the local gauge, and it was thought that some of the mattresses would have to be constructed on temporary inclined ways and floated to and sunk in their positions in the dam, but a resort to this expensive method was made unnecessary by the deposits which occurred before work was actually started, amounting to a depth of about 6 feet near the Tennessee shore and 7 feet near the Elmot Bar shore, which made it possible to construct all the mattresses in place at low water.

The stone required as ballast was stored in about equal quantities on the two banks near the ends of the dam during the high water of 1892, but for want of necessary plant to construct the dam that year the work was postponed till 1893. The brush was obtained partly by river and partly by team haulage from brush bars in the near vicinity of the work. That obtained by river was delivered on barges at Gold Dust Landing and Elmot Bar. The average haul from Gold Dust Landing to the Tennessee end of the dam was over 2 miles, and the cost of the brush from this point and from Elmot Bar, delivered on the dam, was $1.75 and for poles $2.15 per cord. About half the brush used was obtained from this source. The other half was obtained from parties in the near vicinity, at an average cost of $1.56 per cord for the brush and $1.48 per cord for the poles, delivered along the line of the dam. The labor force was divided into two gangs, one working from each end of the dam. For the accommodation of the party at the Tennessee side a temporary house was erected on the main bank. The other party was quartered and subsisted on a quarter boat on the river side of Elmot Bar, abreast of the dam. The banks were first graded, so as to allow the brush teams to drive down into the chute and deliver the brush along the line of the dam. Construction was then commenced at the same time at both ends. In the original plan the foundation sill and the apron mats below it are described as two separate mattresses, each 50 feet wide, with their edges touching. Being constructed in place, it was possible to build both as one mat, and thus

to make the two as one connected whole, 100 feet wide, across the entire chute from bank to bank. As soon as the mattresses had been advanced across the deeper portions of the chute the second layer, or first layer of mattresses of the dam proper, was put under construction, beginning at the shore end. This layer was given a variable thickness, according to the irregularities in the sill mat, so as to make the top of it nearly level. In the construction of this and the other superposed layers of mattresses the top grillage of each mattress was used as the bottom grillage of the one next above it. The second layer of mattresses being completed, the next one was commenced, and so on till the desired height was obtained. In the deepest portion of the chute on the Tennessee side the dam contained five layers of mattresses; on the Elmot side it was four mattresses high; while on the high middle ground near the middle of the chute, it was only one mattress high. The stone ballast was transported from the bank and distributed over the dam by dump cars running on a double steel-rail track laid on top of the mattresses, the tracks connecting by switches with portable tracks leading to the stone pile. The power was supplied by a pile-driver boiler and a double, nonreversing pile-driver hoisting engine, provided with two drums, having separate clutches, permitting either one to be thrown into use at will; the whole operated on the tail-rope system of haulage. One such plant was set up on each end of the dam. When the distance out became greater than 1,000 feet only one track was used, and the cars were operated by the engines of both plants working together, one hauling the cars out, the other hauling them back. It was intended under the original plan to ballast each mattress with its proper amount of stone before carrying the dam any higher. As the method of transportation used required a nearly level surface to work on, no ballast was placed until such a surface was obtained. On the Tennessee side no ballast was distributed until the third layer of mattresses had been placed. No ballast was placed on the fourth, and nearly the entire quantity of stone was distributed over the top mattress. On the Elmot Bar side all the stone was distributed over the top mattress. The original quantity of stone estimated and stored on the bank was about 14,000 cubic yards. This amount proving insufficient, an additional quantity of 4,693 cubic yards was obtained from the stone depot at Ashport Bend.

Details of the construction of the mattresses are shown on Pl. IV. A longitudinal section of the dam is given on Pl. II, and characteristic cross sections on Pl. III.

The protection of the banks above and below the ends of the dam consist of thin but compactly laid brush mats, heavily ballasted, extending from the top of the bank to the foot of the slope. At the Elmot Bar side the mattress extends 300 feet beyond the foot of the slope so as to cover a deep pocket of soft material at that point.

As completed, the dam is in round numbers 3,000 feet long, 13.3 feet high at the highest point on the Tennessee side, and 11.6 feet on the Elmot Bar side. Its least height is 3 feet at the crest of the middle bar. In its construction there were used 17,815.8 cords of brush and poles and approximately 19,000 cubic yards of stone. The total contents are 102,082.12 cubic yards and the total cost $92,977.13, making an average cost of $0.9108 per cubic yard. For further details of construction see report of Assistant Engineer Charles Le Vasseur.

A large amount of settling occurred in the dam during the first considerable rise in January, due to undermining by the current passing through and under the mat. The water first came against the dam on December 12, 1893. The pools above the dam rose 0.6 foot the same day and by the 15th had risen 2 feet. Under this head the water flowed or seeped through the mattress in considerable quantity and with a strong current, but no settling was noted. On January 14, with 9 feet on the local gauge, a large amount of settling was reported to have occurred in the dam over the deepest part of the chute near the Tennessee shore. An examination made the same day showed the dam to have settled at this point nearly to the original bottom of the chute, making a depression through which the water was running about 3 feet deep and 45 feet wide. Other settling was also noted. Several depressions 1 to 3 feet deep had developed near the Tennessee shore, and one 2½ feet deep near the Elmot Bar end. The shore mattress just below the dam at the Elmot Bar end had also been undermined. A wavy appearance of the crest over its whole length indicated more or less settlement at all points. The dam was put under observation from the 14th to the 22d, but the settling noted on the 14th did not appear to increase much, if any, during that interval. The profile of a line of levels run over the dam January 18 is shown on Pl. IX. Excepting the considerable depressions near the Tennessee shore and the one close to the Elmot Bar bank, the average settling along the crest of the dam appears not to have exceeded 2 to 3 feet. No settling is indicated on the highest point of the middle bar where the dam is only one mattress high. The difference of level between the pools above and below the dam on the same day was approximately 2 feet. How much settling, if any, has occurred since January 18 is not known, as the river has not been low enough to run a line of levels over it. As near as can be judged by the eye, the profile of the dam at last inspection in April was very similar in shape to that of January 18, 1894, with no indica-

ion of settling at the highest point of the middle bar. From this circumstance I am lisposed to believe that no considerable settling, unless it is a uniform one, has occurred since the survey of January 18.

The amount of funds required to restore the grade has been approximated from the profile of January 18, and the stone required has been contracted for, to be stored on the bank before the water falls too low to enter the chute.

The placing of any brush parallel with the current appears to have been, from this experience, an error, because from the lesser resistance it offered to the flow of the current through the dam it induced a seepage of rapid current by which the dam was undermined. In adding new mattresses it is recommended that all brush be laid horizontally across the current and that such continuity and strength as the mattress may need in a direction normal to the brush be given by the use of wire strand.

Revetment Fletchers Bend.—The revetment was commenced in 1884 and added to at different times until its present length of 16,500 feet was reached in 1891. Beginning at the upstream end the revetment is continuous for a distance of 12,000 feet. Below this the mattresses were laid in four detached blocks, each 1,100 feet long, with intervals of 300, 400, and 500 feet between them. At the date of last annual report the continuous revetment was in efficient condition, but the detached mattresses had been undermined and injured at the ends by the caving of the unprotected bank between them. A break also existed in the upstream block of the detached mattresses involving the loss of about one-half of its length. The break was located in a strong eddy just under a false point in the revetted bank. It was repaired in August and September of 1893 by a fascine mattress 595 feet long by 250 feet wide, and a connecting mattress 477 feet by 124 feet to cover the space between the main mattress and the water line. The shore paving was carried up only a few feet above low water to the foot of the vertical bank. The grading of the bank and the extension of the paving up the slope to the usual level was not deemed necessary at this point. Some difficulty was encountered in sinking the river mat on account of the strong reverse eddy current near the shore, the effect of which, in the operation of sinking, was to carry the lower inshore corner upstream and to fold it down on the upstream portion of the mat which sunk first, and which lay in the downstream current. To guard against this the lower end of the mat was moored by cables leading to dead men some distance down the bank, but the cables being too light, broke and allowed the inshore portion of the mat for about one-third of its length to double up under the pressure of the eddy action. The cost of this repair was $16,181.93. Nothing has been done on the unrevetted banks between the detached blocks of mattresses, but from present indications these spaces should be revetted as soon as funds can be spared to prevent further destruction of the mattresses and to prevent the bank from taking a bad shape.

Revetment Daniels Point.—This revetment is located at the lower end of Canadian Reach and is 5,300 feet in length. It was constructed in 1889–'90. Its object was to maintain a fixed direction of approach to the upper end of the bend next below it. It was breached in 1891 near the upper end and was repaired the same season by a mattress 300 feet long. The flood of 1892 breached it in five points, the breaks aggregating 3,050 feet in length. Four of the breaks were thoroughly repaired the same season, and the fifth one partially. Soundings were also taken over the mattresses before and after the repairs were made; further injuries were caused by the flood of 1893, and to ascertain their extent and nature under the water surface the sections were repeated in July, 1893. A discussion of the indications which these soundings afforded is contained in my special report of September 27, 1893, on bank revetment. I there expressed the opinion that even if the existing work be repaired and extended upstream, it will still be subject to loss by caving of the bank at the upstream end, and, for that reason, recommended that no further attempts be made to maintain this work, and that when the revetment of this bend is resumed the work be commenced at the upper limit of caving and extended downstream, as funds become available. At a recent inspection the revetment appears not to have suffered much additional damage by the moderate stages of the past high-water period beyond an enlargement of the breaks in the shore mats. No work is recommended for this season.

Osceola, lower bar.—This bar is protected at the upper end by 4,339 feet of revetment, placed in 1883–'84, with mattresses 100 to 150 feet wide, and at the lower end by 5,987 feet of revetment, with mattresses 200 feet wide, constructed in 1890–'91. The upper revetment is protected by an outlying sand bar from a strong attack of the current. Both revetments are in efficient condition, and no additional work is at present required.

Plum Point revetment.—This revetment, constructed in 1888, is located below the mouth of Island 30 Chute, and is 800 feet long. About 12½ per cent has been lost at the lower end by undermining. The remainder is in efficient condition.

Other works.—The other works in the reach, viz, Gold Dust dikes, dikes in the chutes of Elmot Island and Island No. 30, Plum Point dikes, and the dikes behind

Osceola and Bullerton bars, are in substantially the same condition as at the date of last annual report.

Results in Plum Point Reach.—The lowest stage reached in the fall of 1893 was 0.8 foot above zero on the local gauge. The lowest recorded depths were 8 feet at Island 30 crossing and 9 feet at the foot of Gold Dust crossing. These depths were taken at falling river September 20–21, with 1.3 feet on the local gauge, and were subsequently improved as the channel became more clearly defined. The least depths after the river had reached its lowest point were 9 feet at Island 30 and above 10 feet at all other points. A marked improvement was made in Gold Dust crossing by the construction of the Ashport Bend revetment. In 1891 the least depth on this crossing was 6½ feet, in 1892, 7½ feet, and in 1893, 9 feet at falling river and 10 feet after the channel had become well defined. The good results heretofore reported have therefore been well maintained.

LEVEES.

Lower St. Francis Basin levee district.—This district begins at the high ground at Point Pleasant, Mo. (80 R), and extends to the mouth of the St. Francis River (298 R), a distance by river of 218 miles. Up to 1892 no serious steps had been taken by the inhabitants of the district to restore the old levee system which was constructed before the war, but which had long since been abandoned. The disastrous overflow of 1892, following so closely after the equally destructive floods of 1890–'91, and the conviction that the floods of the future would be more frequent and destructive than those of the past, forced upon the people the conclusion that the construction of a complete line of levee to protect against overflow had become a necessity to prevent the abandonment of much of the lands now occupied and a general depopulation of the district. Impelled by this conviction, preliminary organizations were formed in the Missouri and Arkansas sections of the district. Acts of incorporation as levee districts were obtained from their respective State legislatures, and within a year levee boards were organized for the purpose of constructing and maintaining levees. The division of the district by a State line necessitated the organization of two levee boards, each acting under the laws of its own State, but the objection to such dual directorship has been, for the present at least, obviated to a certain extent by the employment by both boards of the same engineering staff. Immediately after organization both boards proceeded to levy a tax from which they expected to realize jointly about $100,000 the first year. In Arkansas perhaps less than one-half the amount levied has yet been collected, and no steps will be made to enforce collection from delinquent payers until the constitutionality of the law under which the board acts, which has been questioned, has been passed upon by the courts. In Missouri, I believe, the delinquencies in payment of the levee tax are equally great. Both boards have constructed levees during the past season. From a report of the chief engineer of the district it appears that the work of the Arkansas board consists of 1¾ miles levee, containing 83,000 cubic yards at the upper end of the bend of Island 35. A much larger amount of work was contemplated and a much larger amount would have been accomplished but for the litigation in which the district became involved, which compelled a cessation of the work until the constitutionality of the levee board act could be judicially established.

The board hopes for an early decision of the question; and, if in their favor, an effort will be made to do a large amount of work this year by negotiating a loan or discounting paper issued against revenues to be collected in the future. The Missouri board, with scarcely any funds in hand, has been able, with the cooperation of the planters living along the line of the levee, to do a large amount of work this season. Having no crops to cultivate, most of the planters who were able to do so undertook to construct the levee along their fronts, receiving in payment script issued by the levee board against future revenues. In this way they have succeeded in building in one season 21 miles of complete and 7 miles of incomplete levee, aggregating 638,816 cubic yards. The work done is concentrated in two blocks. The upper one begins at Point Pleasant and extends downstream about 8 miles by levee to a point 1 mile above Old Stewarts Landing. The lower one begins about 2 miles below Gayoso and extends downstream a distance by levee of about 20 miles. In both blocks there are pieces of incomplete levee and points where no work has been done, amounting to a total length of 7 miles. These gaps are to be closed this season, and the board entertains a hope of borrowing enough money to extend the upper block to Stewarts Landing, to extend the lower block down to the State line and the upper end to a point about 3 miles above Gayoso. This programme carried out, their levee line in Missouri would be continuous, except the gap of 12 miles between Stewarts Landing and a point 3 miles above Gayoso. The board entertains the hope also of closing this gap if the Commission will anticipate by one year the allotment for fiscal year ending June 30, 1896, and do the work under that allotment the coming season, promising on their part to construct, themselves, so much of the levee as the

Government allotment will not cover. My answer has been that I would recommend, as they request, the expenditure of the above allotment this season, provided they could give me assurance of a complete closure of the line from Point Pleasant to the State line. As yet I have received no such assurance, and I have no hopes at present that the board will be able to give it, for the reason that the constitutionality of their levee law has not yet been finally passed upon by the courts, a necessary preliminary to the negotiation of a loan of any considerable amount.

The Commission's allotment of $88,000 for the fiscal year ending June 30, 1894, less 10 per cent, has been expended in extending the Plum Point levee from Bear Bayou (153 miles below Cairo) northward by the construction of a new levee 22,000 feet, or a fraction over 4 miles, in length, and containing 427,000 cubic yards. The work was divided into four contracts. Bids were opened for the two lower contracts July 19, 1893, and for the two upper contracts September 15, 1893, and the work awarded at the following prices: For the two lower contracts, 16.99 and 16.49 cents; and for the upper contracts, 18.49 and 16.98 cents per cubic yard. The three lower contracts have been completed and about 37 per cent of the upper one.

The allotment of $88,000 for the fiscal year ending June 30, 1895, less 10 per cent, is to be expended in extending still farther northward the levee constructed the past season. Contracts have been made as follows, work to be done the coming season:

	Cents.
Lower section, E. Hyner ..... per cubic yard..	18
Middle section, E. Hyner ..... do....	16
Upper section, E. Hyner ..... do....	15

At the prices realized, the levee will be extended to the vicinity of Barfield Landing.

Aggregate yardage of levees to June 10, 1893, not including Plum Point levee, none.

Added by the United States to May 1, 1894	427,000
Added by others up to May 1, 1894	721,900
Total to May 1, 1894	1,148,900

Lost by caving or abandonment, none.

Aggregate remaining May 1, 1894, not including Plum Point levee, 1,148,900.

FASCINE MATTRESSES.

Two forms have been used:

1. Mattresses in which the fascines are placed normal to the current.
2. In which the fascines are placed parallel with the current.

The first-mentioned type was used at New Madrid, Hopefield Bend, Ashport Bend, Fletchers Bend, and for the first three mats at Bullerton Tow-Head. Only one mat, the last at Bullerton, was constructed with the fascines placed longitudinally.

Mattresses with the fascines normal to the current.—The plant required consists of 1 set of mooring barges, 1 set of barges with inclined ways, and 1 set of fascine barges. The barges of each set when placed end to end had a length equal to or greater than the width of mattresses to be constructed. The mooring barges were of the same construction heretofore used with the woven type of mattresses, and were moored across the current in the same way. The mattress barges were also the same as heretofore used, with the following additions: Underneath the platform were placed a number of cable drums, one under each inclined way or skid, on which were wound and from which were paid out, as the construction of the mattress progressed, the steel-wire strand which constituted the longitudinal strength of the mattress and to which the fascines were attached or woven by the method to be hereafter described. The distance between the drums was 8 or 9 feet, according to the particular barges used. At the highest point of each way an iron sheave was placed, over which was passed the strand from the corresponding drum. The drums were all provided with friction brakes, by which a uniform tension was kept on the strands while the mat was in process of construction. The fascine barges were ordinary square-end decked barges, on which were erected temporary platforms the same level as the platform of the mattress ways. These barges were put end to end and lashed parallel to and close up to the downstream side of the mat ways. On the side of the platform nearest the mat ways were erected the formers in which the brush was laid, compressed, and bound into fascines.

Construction of mattress.—The mooring barges being properly moored in position across the current, the mattress ways, to which had been lashed the fascine barges, were brought in position on the downstream side and secured to the mooring barges by three lines, one at the center and one at each end. The first step was to construct the "mat head." This consists of a bundle of poles, 2½ to 3 feet in diameter,

well bound together by wire strand so as to form a beam of great strength, of some rigidity, but having also considerable flexibility. The poles were of hard wood, 5 to 8 inches in diameter at the butt and laid so as to break joints with each other. The beam is as long as the mat is wide, and forms the connecting link between the mooring cables and the mattress. It was moored to the bank by steel-wire cables, independent of the moorings of the mooring barges. The number of cables used depended on the width of mat and strength of current. Eight cables have been used for a mat 300 feet wide. They are spaced at unequal distances apart, being closest together near the outstream end, where the current is strongest, and farthest apart toward the shore, where the current is more moderate. At each point where a cable is to be attached, a heavy manila rope, doubled, is wound around the mat head as indicated on Pl. XIX. Its free ends are passed over the mat and attached to a second and smaller mat head constructed in the mattress 10 feet from the head of the mattress. The other end of the rope is connected by an ordinary shackle to one end of its mooring cable, the other end of the cable being then passed underneath the mooring barge to its anchorage on the bank. The wire strands from the drums on the mattress ways are passed over their proper sheaves and wound around and secured to the mat head. The weaving strands, which are of ½-inch steel strand, and for convenience cut into lengths of about 50 feet, are also attached to the mat head, one for each of the longitudinal strands upon which the fascines are woven.

For the construction of the fascines and mattress the labor is divided into three gangs, one to hand the brush down from the barges, the second to carry the brush to the formers and to construct the fascines, the third to weave the fascines into the mat. The second party, receiving the brush from the first party, carries it to and distributes it in the formers. The brush is put in two layers, one with the tops in one direction, the other with the tops in the opposite direction, care being taken to break joints as far as possible, and especially to prevent two butts from overlapping. Enough brush is put in to make a fascine 10 to 12 inches in diameter. It is then choked every 8 feet and bound into a fascine by No. 12 steel wire. The chokers consist of iron chains of suitable length and strength, having one end secured to one side of the former. Each chain is brought over the brush and a lever inserted through a ring in the free end and borne down upon by the weight of one or two men, compressing the fascine while it is being bound with wire. The third party, assisted by the second party, raise the fascine out of the formers, slide it along the skids which connect the former with the top of the mattress ways, and down the latter to its position in the mattress next to the mat head. The weaving strand is then passed over the fascine, down underneath it and up between the fascine and mat head, crossing at the same time the bottom longitudinal strand. It is then put into a "Haven clamp" and drawn as taut as four to six men can do it with double block and tackle. The strand is temporarily stapled to a pole of the mat head. The second fascine being in place, the weaving strand is passed over the first and second fascine down underneath the second and up between the first and second, at the same time crossing the bottom longitudinal strand as before. It is again attached to the clamp and drawn taut as before by block and tackle and temporarily stapled to a piece of brush in the first fascine. When the strain is first put on the strand, a tap on the pole of the mat head to which it has been temporarily stapled is sufficient to dislodge the staple and allow the strand to completely encircle the first fascine. Details of the method of weaving is shown on Pl. XIV. When the ways have been filled the mattress is launched in the usual way and the construction continued. The tenth fascine is made of hard wood brush or poles, and to it are attached the free ends of the large manila ropes which are wound around the mat head. The weaving and bottom strands are clamped together by a cable clamp every 10 feet, and at points intermediate between the clamps both strands are stapled to the brush to prevent the fascines from separating in the process of weaving. On top of the mattress thus constructed are placed rows of poles, 16 feet apart, extending up and down stream. They are lashed to the fascines by No. 7 silicon bronze wire every 5 feet and at intermediate points by strong steel-wire lashings. The object of the rows of poles is twofold—first, they prevent the stone from slipping off the mat when it is sunk on a steep slope, and second, by being lashed to the body of the mattress by noncorrosive wire they prevent the displacement of the brush after the steel-wire weaving strand and all other corrosive connections shall have rusted away. At the outstream edge of the mat the poles are cribbed up two deep to better insure against the tripping of the stone when the mat is sunk, or when it is subsequently undermined by scour at its edge.

The construction of this mattress, at first slow, developed during the season a rate of progress far exceeding my expectations. At Ashport Bend 6 mattresses, 300 feet wide, were constructed The average number of linear feet constructed per day with the first mat was 74.6; second mat, 82.2; third mat, 101.4; fourth mat, 92; fifth mat, 102.3; sixth mat, 109.5. The greatest progress on any one day was 160

feet with 246⅛ days' labor. At Hopefield Bend 4 mats, 310 feet wide, were constructed, with the following progress: First mattress, average per day, 93 linear feet; second mat, 127 feet; third mat, 140 feet; fourth mat, 153 feet. The greatest progress per day was 175 feet with 342 days' labor. The best progress per day with the Bullerton mattresses, 250 feet wide, was 200 linear feet with 212 days' labor.

The ballasting and sinking of these mattresses have been attended by no special difficulty, but the operations are necessarily more systematic and deliberate than with the old style of mattress, on account of the former's greater weight, density, and flexibility. In ballasting, it is necessary to do the work rapidly and sink the mattress immediately afterwards. This precaution is made necessary by the great compactness of the brush fascines and the rapidity with which they accumulate sediment after they have been pressed under water by the ballast. So rapidly do they accumulate sediment that if there is any considerable delay in ballasting, portions of the mattress on which the ballast may be a little excessive may be carried below the surface of the water by the weight of the accumulated deposit before all is ready for sinking. The mats were sunk in the same manner as the old type of mats were sunk, but the operation was much more deliberate and systematic. Toward the close of the season's work the foremen of the different parties had become so well drilled in their respective duties that a large mattress could be sunk with scarcely a word of command, all necessary directions, which were few in number, being communicated as far as possible by signals well understood by all.

In the construction of 1,000 linear feet of mattress 3,300 feet wide, the following material was used:

Brush	cords..	446.1
Poles	do....	122.4
Stone	cubic yards..	2,741.4
Iron wire	pounds..	14,565
Silicon bronze wire	do....	1,893
¼-inch wire strand	do....	12,348
5/16-inch wire strand	do....	6,600
⅜-inch wire strand	do....	9,960
Staples	do....	558
Clamps	number..	3,696
Piling	feet..	243
Rope	pounds..	498

Brush, not exceeding 3 inches in diameter at the butt, makes a fascine of uniform strength, thickness, and compactness. This limit of size was preferred, but as the brush bars within a considerable distance of the works had been very much depleted in former season's work, brush as large as 4 inches at the butt was accepted, and, at times, even larger brush was taken to avoid embarrassing and expensive delays. The ¼ and 5/16 inch strands included in the above bill of material are used for the bottom longitudinal strands, the ¼-inch size being used at the channel edge of the mat where the current is greatest and the 5/16-inch nearest the shore. Smaller strands than these were used in a few of the mats when the supply of the larger strands fell short, but in such cases additional longitudinal strands were stretched over the top of the mat after it was completed, and clamped at intervals of 10 feet to the weaving strand in the same manner as the latter was clamped to the bottom longitudinal cable. The ¼-inch strand is used exclusively for weaving. Two forms of clamps have been used, the "Crosby" and a homemade clamp. Both are shown in detail in Pl. XX. Various forms of staples have been used. A staple of the fence-wire type 1¼ inches by 5/16 inch made of No. 9 wire is a good, cheap, and suitable form of staple. Stone, not exceeding 35 pounds in weight, was preferred in both ballasting and sinking. Much of the stone which was stored on the bank for the season's work had been contracted for before the fascine type of mattress had been approved, and all of it which exceeded the 35-pound limit was reduced to the proper size by sledging. The application of the other materials mentioned has been previously explained.

The mattress here described is believed to fulfill more perfectly than the old type of woven mattress the conditions which are essential in the subaqueous portion of the bank's protection These conditions are:

(1) The mattress must prevent the material of the bank from being eroded by the attack of the current through the body of the mattress.

(2) It must prevent the material under the mat from being washed out through it by the return flow of water from a saturated stratum of the bank when the river is on a falling stage.

(3) It must possess enough flexibility to follow rapidly and without danger of rupture the scour which takes place at the channel edge of the mattress for several years after its construction and until the mat has reached its permanent bed.

(4) When the scour at the channel edge of the revetment has reached its ultimate development, and the mattress has reached a permanent bed, the mattress itself must possess the element of long life or permanency.

The compactness with which the brush is laid in the fascine mattress and the thickness of the mattress itself, which approximates 1 foot, afford ample security against the attack of the current upon the bank through the body of the mattress, and the flexibility which this mattress possesses will permit it to follow, without danger of rupture, any scour which may take place at its edge.

The only two questions in doubt are those expressed in the second and fourth conditions. Whether or not the mattress as constructed possesses enough compactness to prevent the transport of material through it by the return flow of water from a saturated stratum of the bank, only time can tell, but there can be no doubt that in this particular, whether it fail or not, the fascine mattress possesses very great advantages over the old style of mattress in which the brush was woven more or less loosely in a single layer. As regards the question of permanence, two factors are relied upon to fulfill this condition. The first is the riprap distributed over the mattress in ballasting and sinking. As the fascine mattress contains 50 per cent more brush than the old woven type, the quantity of stone required to ballast and sink a given area is proportionately greater. The stone being also of small size the amount distributed over the mat in the process of ballasting alone is sufficient to form an almost continuous pavement of stone blocks over the whole length and breadth of the mattress. If, when the mattress is sunk, and subsequently when the mattress follows the scour at its edge, the stone does not slip down the slope, the original ballast, together with the additional quantity added in the process of sinking, will form so continuous a layer or paving of stone as to prevent the displacement of the brush even after the weaving strands and all other perishable connections are rusted away. As an additional precaution against the displacement of the brush when the steel strand shall have rusted off, the longitudinal rows of poles, which are 16 feet apart, are lashed to the body of the mattress by a noncorrosive wire, which shall permanently hold the pole system intact and prevent the displacement of any brush when the ballast may for any cause become unevenly distributed. The mattress is open to the criticism that all of its longitudinal connections are of a perishable nature, but events may prove that this objection is more fancied than real. The function of the longitudinal fastenings is to tie the mat together longitudinally, to hold it together until it is on the bottom, and until all the scour that will probably take place at its edge has taken place, and the mat has reached its permanent bed. This done, the steel wire strands have performed all the functions they were designed for and all they can perform, and permanence thereafter will depend upon the stone ballast and the noncorrosive lashings on the longitudinal poles, and, if these prove effectual in preventing the displacement of brush after the steel wires have rusted away, the objection to the use of a perishable material in the weaving of the fascines into a mattress will be overcome.

Fascine mattress with the fascines placed parallel to the bank.—The oblique position of the mattress-head cables to the head of the mattress in the form of construction just described exerts a strong shore thrust on the mat head in the process of sinking. This thrust is taken up by the strong mat head and the mat itself, which, together, have the requisite rigidity to withstand the thrust without danger of doubling up. Owing to the very much greater lateral flexibility of the mattress in which the fascines are parallel to the bank, it was not deemed safe to have any shore thrusts at all and the mooring arrangements were accordingly modified. A set of mooring barges was anchored at the head of the mat in the usual way by mooring cables passing obliquely upstream to dead men on shore. A second set of mooring barges was moored in the same way 800 feet above the lower set. On the deck of the upper barges was placed a continuous line of log dead men, chained to the timberheads held by the shore cables. These dead men were to hold the cables mooring the mattress and mattress plant. As the mattress was constructed its mooring cables were attached to it in the manner to be hereafter described, passed underneath the lower mooring barges, carried upstream parallel with the bank, and secured to the line of dead men on the upper barges, thus avoiding any shore thrust upon the mat head. The mattress plant consisted of four mattress ways and their corresponding fascine barges, lashed end to end, giving a combined length of 588 feet. The barges were moored parallel to the bank and with the ways inclining toward the shore. The fascines were made 588 feet long, the full length of the mattress. The mattress was constructed by beginning at the water line and extending outstream until the full width of 250 feet was made. The details of construction were the same as those heretofore described for the mat in which the fascines are normal to the current. To give the mattress more longitudinal strength than the fascines themselves possessed, 1½ and 2¾ inch strand, extending the whole length of the mat, were built into it in the following manner: When the construction reached the desired point the longitudinal strand was stretched across the bottom strands of the mattress and clamped to

them at the points of intersection by common clamps. The upstream end of the strand was given two turns around the mattress head and carried back and clamped to itself at 130 feet. For additional security the longitudinal strands were connected together by a diagonal system of backing-up straps 100 feet below the head of the mattress, as shown on Pl. XIII. The mattress head of this mat differed from previous construction, in that it was a kind of jointed spar designed to adjust to the bed of the river when sunk. This spar was made of 14 cypress logs about 12 inches in diameter and varying in length from 28 feet next to the shore to 14 feet on the outstream end, all put in place before launching from mattress boats. The logs were placed on top of the mattress and about 3 feet from the head of the mattress with laps of 2 feet. A ¾-inch driftbolt 2 feet long was driven horizontally through both logs at each lap, and in addition the logs were bound together by several turns of wire strand at the pin points. The logs were secured to the fascines by two wrappings of ½-inch strand, and to every alternate log two of the longitudinal wire strands were made fast. Spanning these alternate logs 2-inch manila ropes were made fast at the same points, receiving the longitudinal strands. Each one of these rope loops formed an equilateral triangle, with its log for base and with the shackles of its mattress mooring cable at the vertex. Parallel lines of poles 16 feet apart were wired to the mattress normal to the current and bank by lashings 5 feet apart, each alternate lashing being silicon bronze wire. The object of these poles was twofold: first, to give the mattress some stiffness, as without them it was feared the mat would be so flexible as to fold up in sinking, and, second, to give to the mattress an element of permanence by its noncorrosive wire lashings. Parallel rows of poles were also placed longitudinally to keep the rock from rolling off the mattress. The mattress was ballasted and sunk without incident worthy of special notice and under conditions more severe than the average. The river was on a rise, the current strong, and a considerable amount of drift was encountered. The experiment has demonstrated that mats of this description can be constructed and handled safely on a large scale if it should prove a better protection than the mattress with fascines placed normal to the current.

SECOND DISTRICT (FOOT OF ISLAND NO. 40 TO MOUTH OF WHITE RIVER, 180 MILES).

Revetment, Hopefield Bend, 227–230 miles below Cairo.—The revetment of this bank begins at Mound City and extends to Hopefield Point, a distance of over 3 miles. From Mound City down to a point about 2 miles above Hopefield Point the old revetment is protected by an outlying sand bar, and though the shore work is more or less disintegrated and the mattress of less size and strength than later experience has shown to be necessary, no repairs have been made, and none will be required as long as the outlying sand bar is not washed away. The lower 2 miles of the revetment has been subject to the attack of a very rapid current, which, reaching a maximum of over 8 miles per hour, has breached the original work from time to time, necessitating the expenditure of large sums annually in repairs since the first breach occurred in 1890. The repairs made during the seasons of 1890, 1891–'92, and 1892–'93, constituted a complete renewal of all the original revetment except two blocks, one of which, 2,000 feet long, extends from the foot of the repair work of 1890 at station 58 to the head of a 1,000-foot mattress of 1892–'93 at station 78; the other, 500 feet long, begins at the foot of the same mattress and extends downstream 500 feet to the end of the original work. Both blocks were breached during the flood of 1893 while the river was at bank-full stage. Soundings were taken across the revetment at sections 100 feet apart in May, 1893, while the river was still high. A comparison of these with similar soundings taken over the same sections in November and December, 1892, showed that the mattress of the blocks in which the breaches had occurred had settled at a number of points, the settling being least at the channel edge and greatest near the water line. A further examination at low water in August of 1893 showed that the flood of 1893 caused almost a continuous break in the old revetment at and above the water and a recession of 75 feet in the bank line opposite the lower block of 500 feet. The repairs determined on, and for which an allotment of $100,000 was made, consisted in an entire renewal of the first block of old work by fascine mattresses 300 feet wide, including a complete paving of stone extending from the edge of the subaqueous mattress up to or above the level of two-thirds high-water stage, and a like renewal of the second block of 500 feet, including an extension of the latter 500 feet farther downstream so as to cover the lower side of Hopefield Point, which had exhibited a tendency to cave. The repairs were made by the party engaged early in the season at New Madrid. Work was commenced September 1 and completed December 1.

The materials and supplies used were obtained partly by contract and partly by open-market purchases, and the work was done by day labor. The stone was obtained from J. B. Killibrew & Co., from quarries at Imboden and Black Rock, Ark., and delivered partly on barges at West Memphis and partly on the bank in

the immediate vicinity of the work. By special agreement the stone so purchased from Mr. Killibrew was to be regarded as a part of his contract with Captain Townsend for furnishing stone to the Third District. Under this agreement Mr. Killibrew furnished 4,016.04 cubic yards of crushed rock, at $1.75 per cubic yard; 16,084.21 cubic yards of riprap, not exceeding 35 pounds in weight, for $1.69 per cubic yard, on the bank or on barges. The brush was obtained by open-market purchase from Messrs. Hunter & Frey, of Memphis, at $1.02 per cord for brush and $1.50 per cord for poles.

The season's work included the construction of three mats, 650, 700, and 800 feet long, covering the upper break, and a fourth, 916 feet long, covering the lower break and the under side of Hopefield Point. All were 310 feet wide, and the cost $6.034 per square of 100 feet, or $18.10 per linear foot. Of connecting mats there were made 2,175 linear feet, amounting to 1,221.2 squares, at $6.987 per square. The grading was postponed till after the mattresses were sunk. The slope was 1 on 3. This work included 1,975 linear feet of bank graded and 28,940 cubic yards of material moved at a cost of $0.054 per cubic yard.

The paving began at the edge of the connecting mattresses near the low-water line and extended up the graded slope to from 26 to 30 feet above low water. It was carried to this height to get above a stratum of sand. The average thickness of the paving was 10 inches, of which 3½ inches was crushed rock placed on the surface of the ground and 6½ inches of riprap placed on the layer of crushed rock. The amount of paving done was 3,112 squares and the cost $9.20 per square. The total cost of the work, including an item of $4,469.27 for work on other portions of the revetment, was $96,814.43. Not including the above item, the cost was $92,345.16, or $31.52 per linear foot of bank protected. (For further details see report of Assistant Engineer William Gerig.)

The new mattresses were sounded along sections 100 feet apart in November and December, 1893, and again at medium stage in May, 1894. A comparison of the two sets of soundings indicates settling at a few points, but the settling is not great enough and not sufficiently uniform from section to section to permit the deduction of a reliable conclusion as to the cause. The soundings will be again repeated during the coming low water.

Memphis Harbor, 230 miles below Cairo, Sand Bar.—A full description of the sand bar which obstructs a portion of the public landing is given in former annual reports. In its present development it covers over 1 mile of the city front below the mouth of Wolf River, obstructing the landing at the Anchor Line elevator and about two-thirds of the paved levee. A further growth of the bar down the levee may be anticipated, but without much increase in its width. All the boats seeking this port will probably not be able to effect a landing close up against the paving at next low water, as they have done heretofore. The evident solution of the difficulty for this year and for several years to come will be to use wharf boats, anchored at the edge of the bar, and connected by landing stages or bridges with the pavement of the levee. Then, at some future time, when the bar has expanded to its full length and width, the use of wharf boats can be again dispensed with by extending the paving of the levee out to the edge of the bar.

Bank protection.—The river frontage of the city extends from the mouth of Wolf River to the Kansas City and Memphis Railroad bridge, and is 13,300 feet long. Of this, 9,500 feet have been protected from caving as follows: From the mouth of Wolf River to the foot of Beale street, a distance of 6,500 feet, it is protected by brush and stone mattresses, laid at various times between 1878 and 1887; for a distance of 2,100 feet below Beale street it is protected by the citizens' dikes, constructed in 1886 and 1887; and for a distance of about 1,000 feet above the bridge it is protected by a continuous revetment, constructed by the bridge company as a protection to its shore pier and abutment. These revetments are believed to be in good condition and in no need of repair. The only portion of the bank unprotected is that included between the lower end of the citizens' dikes and the upper end of the bridge company's revetment, and is 3,800 feet long. In its last annual report the commission has included an estimate of $100,000 for the purpose of revetting this interval.

Nonconnah Rock, 236 miles below Cairo.—The rock is located in Tennessee Chute opposite the mouth of Nonconnah Creek. Since 1890 the channel of the river at low water has occupied a narrow span of 700 feet between the rock and the Tennessee bank, where towboats have some difficulty in flanking the bend without coming uncomfortably near to this obstruction. At the date of my last annual report a contract had been let to remove the rock, under an allotment of $6,000 made for this purpose. The work of removal was commenced the latter part of September and suspended in November on account of rising river.

The plan of operations was to honeycomb the rock by a number of well-distributed charges of dynamite to be exploded simultaneously with the expectation that a large portion of the rock would be pulverized fine enough to permit its being washed away by the river current and the remainder of it broken up in small enough pieces

to permit easy removal by dredging. The results of this plan as related by the contractor were far from satisfactory. The rock was not pulverized nor broken up into small fragments, but, on the contrary, the experiment proved nearly a total loss in both time and money by the cementing together of the blasted rock before it could be dredged out. This necessitated a resort to surface blasting to loosen the material for the dredge.

A survey of the rock made November 20 and 24, 1893, as compared with the previous survey of September, 1892, shows that only 335 cubic yards of rock has been removed and the height of the rock reduced only 3½ feet, bringing it to the level of 1-foot stage below low water.

Helena Harbor, 306 miles below Cairo.—The work of improvement consists of a continuous revetment 600 feet long and of 5 spur dikes, constructed in 1889–'90, to protect 3,000 feet of caving bank in front of the town. It is fully described in previous reports. Its condition is substantially the same as described in last annual report.

LEVEES.

In the second engineer district are included the lower part of the Lower St. Francis Basin to which allusion has been made in the report of the first engineer district, also the Upper Yazoo levee district on the left bank and the Upper and Lower White River levee districts on the right bank. Work has been done during the year upon both fronts under contracts made during the last fiscal year.

Upper Yazoo levee district, 244 to 365 miles below Cairo.—This district has a river frontage of 120 miles and contains 110 miles of levee. The levees are in a higher state of efficiency than in most other parts of the system. They have generally grades 3 or 4 feet above the highest recorded water, full crown and section, and banquettes where the height makes it advisable. During the past season the following levees were raised and enlarged under the contracts in force at the beginning of the fiscal year:

10,500 feet along mile sections 57–58 (304–307 L).
12,800 feet along mile sections 60–62, 63 (309–312 L).
16,800 feet near Malone's Landing (356–358 L).
11,900 feet below Pushmataha Landing (360–365 L).

The season's work included also the construction of a new levee below Lake Charles (358 L), where the old levee was threatened by a caving bank. The levees were raised to a uniform grade of 4 feet above highest recorded water and were given a width of 10 feet on top and side slopes of 1 on 3. A banquette was added to a portion of the levee near Malone's Landing, where the foundation was not good.

The prices paid varied from 12.24 to 20 cents per cubic yard. The total amount of material placed in the levee during the year was 521,800 cubic yards, and the total cost, including office and engineering expenses, was $92,511.81.

Under the provisions of the river and harbor act of July 13, 1892, the allotment of $100,000 for this district for the fiscal year ending June 30, 1895, less 10 per cent, has been put under contract and will be expended in enlarging the existing levee from Austin, Miss. (289 L), northward for a distance by levee of 20 miles. As the proposed enlargement lies above the mouth of the St. Francis River, and as the water along its front will rise higher when the St. Francis levees are completed than it has in the past, the grade has been fixed at 5 feet above the highest recorded flood. The crown will be 10 feet wide and side slopes 1 on 3. The work was let in four contracts and operations on three of them have already commenced. The prices paid range from 11⅓ to 16.98 cents per cubic yard.

	Cubic yards.
Aggregate contents of levees May 1, 1893	8,280,749
Added by the United States between May 1, 1893, to May 1, 1894	521,800
Added by the local district between June 30, 1893, and May 1, 1894	299,147
Total to May 1, 1894	9,101,696
Lost by abandonment May 1, 1893, to May 1, 1894	101,350
Aggregate remaining May 1, 1894	9,000,346

Upper White River levee district, 306-340 miles below Cairo.—This district comprises the upper half of the narrow belt of overflowed land, averaging about 10 miles in width, which lies between the Mississippi and White rivers. The levee begins at the foot of Crowley's Ridge, at Helena Ark. (306 R), and, at the date of last annual report, had been extended to Yellow Banks Bayou, a distance by levee of 22 miles. During the past season the levee has been extended southward 6,500 feet by a new levee, and the existing levee for a distance of 8,045 feet above Yellow Banks Bayou has been raised and enlarged. The contracts under which the season's work was done were let during the last fiscal year, and an abstract of same is included in my last annual report. The levees constructed the past year have been raised to a grade

of 3.5 feet above the highest recorded water, which, in this locality, was that of 1890, and were made 8 feet wide on top with side slopes of 1 on 3. For the projected work of the coming season the section will be the same, but the grade will be raised to 4 feet above the 1890 flood. The amount of material placed in the levee during the year by the United States was 269,106 cubic yards. The work was difficult and expensive, and the prices paid ranged from 21⅞ to 27 cents per cubic yard.

Under the provisions of the river and harbor act of July 13, 1892, the allotment of $53,000 for this district for the fiscal year ending June 30, 1895, less 10 per cent, has been put under contract and will be expended in extending the existing levee southward a distance of over 4 miles. The work has been let in three contracts, and at this date operations have been commenced on two of them. The prices paid are low and range from 10.45 to 16½ cents per cubic yard.

	Cubic yards
Aggregate contents of levee May 1, 1893	1,374,191
Added by the United States up to May 1, 1894	269,106
Added by the local district up to May 1, 1894	None.
Total to May 1, 1894	1,643,297
Lost by caving or abandonment May 1, 1893, to May 1, 1894	None.
Aggregate remaining May 1, 1894	1,643,297

Lower White River levee district, 340–385 miles below Cairo.—This district comprises the lower half of the narrow belt of overflowed land between the Mississippi and White rivers, and its line of levee when joined to that in the upper district will form one continuous levee, beginning at Helena, Ark., and extending downstream to a point about 5 miles below Henrico, a distance by river of about 80 miles. At the date of last annual report the levee in the lower district had developed to a length of 21½ miles fronting on the Mississippi River and had been extended northward, to a point opposite the head of Island No. 68 (362 R). During the past season the levee has been extended 20,000 feet, or nearly 4 miles farther northward to a point opposite Offut's Landing, Ark. (346 R), and the existing levee has been raised and enlarged for a distance of 7,200 feet in the vicinity of Laconia, Ark. (374 R), where the foundation had developed serious defects. The contracts for the new levees at the upper end of the system were let during the last fiscal year, and that for the enlargement at Laconia was let during the current year under a balance of funds that was left over from previous allotments. The prices paid were 12 cents for the enlargement and 14½ and 18¾ cents per cubic yard for the new work. The total quantity of material placed was 430,173 cubic yards, of which 49,198 was enlargement and 380,975 new levee. The grade and section are the same as in the upper district.

Under the provisions of the river and harbor act of July 13, 1892, the allotment of $75,000 for this district for the fiscal year ending June 30, 1895, less 10 per cent, has been put under contract and will be expended in enlarging the Big Henrico levee near Henrico, Ark. (383 R), to the extent of 50,000 cubic yards, and in extending the upper end of the system northward from its present terminus near Offut's Landing.

The prices realized were 12.98 cents per cubic yard for the enlargement at Henrico, and 15½ and 15.95 cents per cubic pard for the new work of extension at the upper end. Under these prices it will be possible to extend the levee during the coming season a distance of 16,700 feet, or 3⅛ miles.

This extension added to the projected extension southward of the levee in the upper district will reduce the gap between the two levee systems to a length of 9¾ miles.

	Cubic yards.
Aggregate contents of levees May 1, 1893	1,200,638
Added by the United States to May 1, 1894	430,173
Added by the local district to May 1, 1894	None.
Total to May 1, 1894	1,630,811
Lost by caving or abandonment to May 1, 1894	None.
Total in place May, 1894	1,630,811

SURVEYS, GAUGES, AND EXAMINATIONS.

In the first district the surveys made during the year include the usual hydrographic survey of Plum Point Reach at low water and special examinations of the revetments at New Madrid, Mo., Daniels Point, Ashport Bend, Osceola Bar, and Bullerton Bar, also routine observations, when practicable, of the shoal crossings in Plum Point Reach.

The surveys in the second district made during the year include a special examination by soundings of the revetment at Hopefield Bend, a survey of Nonconnah, Rock, a hydrographic survey of the river from Old Town, Ark., to Knowlton's, Ark., a distance of 40 miles, and a survey of location for a levee to connect the levee systems of the Upper and Lower White River levee districts. In September all the crossings and shoal places within the limits of the first and second districts were located and sounded by the survey party. A complete list of the soundings and the depths obtained is appended to this report.

PLANT OF FIRST AND SECOND DISTRICTS.

At the close of last season's work the floating plant and other property, excepting that in the United States warehouse at Elmot, Ark., was collected about one-half mile below Memphis to be cared for until again required, and to receive necessary repairs. The repairs to the steamers have been extensive. The *Minnetonka* has received a new deck, guards, fantails, and pitmen, and extensive repairs to the boiler-settings, pipes, and machinery, including boring out of cylinders. The steamer *Titan* has been docked to receive new planks at the water-line and an adjustment of her hog chains. Steamers *Graham* and *Abbot* have both had extensive repairs to hulls, pipes, and machinery. The hull of the *Itasca* has been replated and the pipes and machinery have been thoroughly overhauled and repaired, including boring out of cylinders. Large graders, Nos. 2 and 4, have received considerable repairs to hulls and machinery. They are old, having been built in 1881, and will last about two years more. The hulls of office boats *Mississippi* and No. 39 have been rebuilt. Store boat No. 26 has been repaired by replacing the hull by the hull of a fairly good coal barge. Quarter boat No. 11 is being repaired in a similar way. Machine shop boat No. 1 has been extensively repaired. Pile-drivers Nos. 19 and 21 have been docked and their hulls, decks, and leads rebuilt. Pile-driver No. 20 will be similarly repaired. Mat barges Nos. 5 and 6, which were converted from coal barges, have received extensive repairs, 3 sets of fascine barges have been fitted up, 7 decked barges have been thoroughly repaired, and minor repairs have been made to other pieces.

A statement of expenditures showing the amount expended on each piece and a list of property on hand, with its estimated present value, is hereto appended.

The plant has been increased during the year by the purchase of 29 decked barges 120 by 30 by 6 feet, 4 small flats and 2 mattress ways, and has been decreased by the condemnation and sale of 5 pile-drivers, and the loss of 1 barge by sinking.

In addition to the above, the plant was temporarily increased during the season by the transfer of 2 steamers, 2 mat barges, 20 decked barges, and 4 quarter boats from the third district, and by the charter at different times of 10 barges, 1 towboat, and 2 harbor tugs.

EXPERIMENTAL DREDGE.

The drawings and specifications for the dredge have been prepared by the dredging committee, and to me has been assigned the duty of disbursing the funds allotted for its construction.

The preparation of the detailed drawings was commenced in the fall of 1892, and the contracts for the heavy parts requiring longest to complete were let before the close of that year. Contracts for other parts were awarded from time to time as the specifications for them were completed. The hull, boilers, and cabin were awarded to Ed. J. Howard, Jeffersonville, Ind.; the centrifugal pump and its suction pipe to Joseph Edwards & Co., New York; the screw or propellor pumps to E. P. Allis Company, Milwaukee, Wis.; the forward suction pipe, piping in the hull of the dredge, and the first invoice of floating pipes, to Chas. Hegewald Company, New Albany, Ind.; and to Kupferle Bros., St. Louis, was awarded the construction of the more delicate parts, as the weighing apparatus, velocimeters, etc. A second invoice of floating pipes, was obtained from the Springfield Boiler Manufacturing Company, Springfield, Ill.

After much delay the hull, with no machinery except the centrifugal pump on board, was launched at Jeffersonville, Ind., August 27, 1893, in a nearly completed state, and on the 27th, with three barges as lighters to carry the heavy iron work, was started down the river in tow of the steamer *Racket*, en route to St. Louis. Progress was delayed by grounding on shoal bars and the dredge did not reach St. Louis till September 18. After arrival there the work of completing the unfinished contracts was rapidly prosecuted under the immediate supervision of Colonel Flad. By October 28 the dredge was ready for experiment, and a trial of the machinery was had that day in presence of the Commission. Experiments were then commenced and were continued at St. Louis during the month of November. On appearance of ice December 1, the dredge was taken in tow of steamers *Titan* and *Vidalia* and

started for Memphis, arriving there January 1, 1894, after a detention of over two weeks at Grand Tower, Ill., by ice and low water. Contemplated changes in the floating pipes commenced at St. Louis were then completed and the experiments continued through January and the early part of February on the sand bars in the vicinity of Memphis. Further experiments pumping sand were then discontinued and the dredge was placed in temporary harbor with the first and second district fleet below Memphis. Further trials have since been made with the Allis pumps to test their capacity. At this date the Allis sand pump has been accepted and the final trials with the jet pump are in progress.

The results of the experiments so far made may be summarized as follows:

The Edwards centrifugal pump has from the beginning given satisfaction, and has developed a capacity far exceeding the requirements.

The Allis sand pump, as at first designed and constructed, failed to deliver the requisite quantity of water on account of deficient engine power. This difficulty was overcome by inserting a new screw with less area of blade. The effect of this change was to permit the engine to develop greater speed and power, and at the same time to increase the capacity of the pump. After a long series of trials extending over a period exceeding two months the requirements of the contract have been fulfilled and the pump has been accepted.

The screw pump which was intended to supply the jets at the end of the forward suction pipe fell far short of its requirements in its first test. The explanation given for this was that the blades of the screw did not completely fill with water. Guide vanes were then inserted with but little effect upon the previous results. Finally a new screw, constructed upon a design in which the centrifugal principle is an important feature, has been inserted, and from the results so far obtained with it promises fulfillment of the contract stipulations.

The principal trouble experienced with the floating-pipe system has been the kinking of the pipes, due to the reaction of the discharge at the point of efflux. Devices to overcome the effect of this reaction are at present under consideration, and will be attached to the pipes before the experiments are resumed. Another difficulty encountered was the sinking of the pipes by choking with sediment when the proportion of sand to water became excessive. Experiments show that when the sand exceeds 15 per cent of the mixture the pipes accumulate sediment, and when it exceeds 20 per cent they rapidly choke up, stop the flow, and cause the pump to lose its priming. For reasons of safety during the experiments, additional buoyancy was given to the pipes by empty oil barrels lashed under their sides. The real reason for the sinking of the floating pipes was the absence of the proper control over the proportion of sand entering the suction, which control is a matter of some difficulty with the after suction pipe, designed by Joseph Edwards & Co., which was used in most of the experiments. As the forward suction pipe, with its jets to stir up the sand, promises a more regular feed than it is possible to get with the after pipe, it is now proposed to connect the former with the Edwards pump for the experiments to be made the coming season, and the necessary additional piping for this purpose has been ordered. Plans are also in preparation for more floating pipes in addition to those already purchased.

Respectfully submitted.

S. W. ROESSLER,
Captain of Engineers.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

Sounding shoal bars—Cairo to White River, September 18–28, 1893.

Location.	Distance from Cairo.	Depth.	Remarks.
	Miles.	*Feet.*	
Cairo Point to Filmore City	1½	9	Sept. 18, Cairo gauge, 6½.
Head of Putneys Bend	10	12	
Island No. 2 to Lucas Bend	12	23	
Lucas Bend to Columbus	21	22	Belmont gauge, 5¾.
Medleys Crossing	29	10	
Hickman Bend	35	20	
Below Hickman, Ky	39	16	
Island No. 8 to James Bayou	43	15	Sept. 19.
Lesters Crossing	54½	14	
Tolers to La Forge	62½	21	
La Forge to Watsons Point	67	10	
Watsons Point to Morrisons	68	13	Morrisons gauge, 5½.
Black Bank to Watsons	73½	14	New Madrid gauge, 5½.
State line (Kentucky and Tennessee)	76½	7½	
Wreck of Guiding Star	77	9	
Point Pleasant	79½	12	
Above Lazelles Landing	82	9½	
Ruddles Point to Silvertop	85	11	
Upper Cherokee Crossing	88	6	
Opposite Stewarts Landing	89½	11	
Lower Cherokee	90½	13	
Batsells Landing	91	14	
Atkinsons Landing	91½	7	
Le Dukes Landing	101¾	10	
½ mile below Le Dukes	102	15	
Hathaways Landing	102½	10	Sept. 20.
Head Island, No. 18	120	13	Cottonwood gauge, 3½.
Cottonwood Crossing	123	17	
Mitchells Point to Lintdale	124½	12½	
Medway to Island No. 21	128	12	
Opposite Hickman Landing	131½	13	
Bend Island, No. 25	145	12	
Island No. 26 to O'Donnells	149	12	
Gold Dust	157	14	
Opposite Dike Elmot Bar	158½	10	
1 mile below Fletchers Landing	159	9	Amelia gauge, 1⅞.
New Haven	162½	8	Sept. 21.
Plum Point to Bullerton Tow-head	166	11	
Plum Point to Osceola Bar	165½	9	
Bullerton to Yankee Bar	168¾	13	
Yankee Bar to Craighead Point	170	11	
Fulton to Island No. 34	177½	11	Fulton gauge, 6¾.
Island No. 34 to Hatchie	180¾	10	
Hatchie to Morgan Point	181½	9	
Morgans Point to Bluffs	182½	18	Sept. 22.
Bend Island, No. 35, to Cedar Point	196	18	
Cedar Point to Deans Island	197½	18	
Deans Island to Densford Light	199½	18	
Centennial Island to Foglemans Chute	207½	13	
Head chute Island No. 40	212½	12	
In chute Island No. 40	213½	10	
Do	215	18	
Head Island No. 40 to Bradleys	213	6	
Old Hen Light to Hopefield Bend	227½	10½	Memphis gauge, 4.
Bridge to foot of bluffs below incline	233½	8	Sept. 23, Memphis gauge, 4¾.
Presidents Island from Tennessee Chute	238¾	13	Sept. 25, Memphis gauge, 4¾.
Reeves Landing to Horn Lake Bend	243¾	10½	
Scanlans Tow-Head to Cow Island Bend	248	10	
Cow Island to Cat Island Bend	254	12	
Star Landing to Harklerodes	259	15	
Polks to Blue Point	268½	15	
Peters Tow-Head to light below Commerce	270¾	10	
Light below Commerce to Peters Landing	271½	10	
Peters Landing to Mhoons	274	20	Mhoons gauge, 2¾.
Mhoons to head Walnut Bend	278	21	
Walnut Bend to Fox Island	290½	18	Sept. 26.
Fox Island to Hardins Point	294	13	
Hardins Point to O. K. Landing	296½	18	Do.
Harbarts Landing to St. Francis Island	300¾	18	
Prairie Point to Island No. 60	309	13	Do.
Williams Landing to Montezuma Bend	319	14	Sept. 27, Helena gauge, 5.3.
Friars Point to Westover Landing	327	15½	
Allisons to head Island No. 62	337½	18	Sunflower gauge, 0.7.
Gradys Landing to Scrub Grass Island	394	14½	Sept. 28.
Montgomery Point to Victoria Bend	398	15½	Gumbyville gauge, 9.5.

APPENDIX 2 A.

REPORT OF ASSISTANT ENGINEER WILLIAM GERIG ON IMPROVEMENT OF HARBOR OF NEW MADRID, MO.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., December 20, 1893.

CAPTAIN: I have the honor to submit my report on the New Madrid, Mo., harbor work during July and August, 1893:

The work covered by the project was to put in a fascine mat 12 inches thick, 250 feet wide, and 1,000 feet long, or as long as could be built by the appropriation, the mat to begin at the upper end of the high ground on which New Madrid is located or at Dry Bayou.

Construction.—Work began immediately after the arrival of the plant at New Madrid, Mo., on July 21, 1893, and was finished August 31. The weather was very favorable, and the river remained practically at the 10-foot stage.

Labor.—The supply was not very abundant. Whites, subsisted by the Government, were employed in all responsible positions. At first the common laborers were whites and self-subsisting, but, owing to the hot weather and hard work, they were soon replaced by negroes. The price paid was $30 per month and subsistence. The self-subsisting labor received $1.25 per day of eight hours.

Materials.—Brush and poles were obtained by contract at $1.05 per cord for the former and $1.50 per cord for the latter, and the source of supply was from 10 to 30 miles above the work. The deliveries were not sufficient, owing to the fact that the estimated quantity to be used per day was too small.

Stone was obtained by contract from the quarries at Apple Creek, Missouri, and stored on the bank during the spring.

Fascine mattresses.—The method of holding the barges and the mat, by means of cables fastened on the bank, was the same as in previous years.

A set of platform or fascine barges were used in addition to the mat barges, and joined to them longitudinally. The platform barges were ordinary barges with an extra deck raised to the level of the platform on the mat barges. Along the side of these, joining the mat barges, formers were built in which to construct the fascines, the tops of these formers being the same elevation as the highest point on the mat ways. Under the platform of the mat barges were placed 19 reels 13 feet apart, the two outside reels containing $\frac{3}{4}$-inch and the others $\frac{7}{8}$-inch galvanized steel strands (made of 7 wires each). These are the bottom cables, and the ends of each were made fast to the head and are under the mat at right angles to the fascines. Each cable was in one piece, its length being determined by the length of the mat. Friction brakes were used on the reels to keep these cables taut.

The method of procedure during the construction of a fascine mat was: First, a large head about 3 feet in diameter was made of hard-wood poles, the diameter of the butts of the poles being from 4 to 8 inches, and to this head were fastened the bottom cables. The weaving strands, which were $\frac{1}{2}$-inch galvanized-steel strands, composed of seven wires, were also fastened to the head at the same places as the bottom cables, and hence there were nineteen of these 13 feet apart. A fascine was made by placing brush from 1 to 4 inches in diameter at the butts in the formers and compressing them into round bundles or fascines 12 inches in diameter by means of the lever chains, and, while thus compressed, were tied together with No. 12 galvanized-steel wire. Care was taken to keep the butts well scattered. The fascine was next raised out of the formers and pushed to the ways and down to the head, when the weaving cable was passed over the fascine, then down under the fascine and bottom strand, up between the fascine and head; then a pair of 6-inch blocks, one end fastened to the mooring barges and the other—by means of a "Haven clamp"—attached to the weaving strand, and 6 men at each set of blocks pulled the fascine down to the head. While the strain was on the weaving strand it was either clamped to the bottom strand or held so the fascine could not separate from the head, or one from the other, by driving a staple into the butt of a willow so as to take both the weaving and bottom cables. The weaving and bottom cables were clamped together, every tenth fascine besides being stapled, so that the fascines could not slip apart. This method was continued until the mat was built of the desired length.

The labor on the mat was divided into three parties; one party unloaded the brush off the barges, the second party carried the brush to the formers and made the fascines, and the third party assisted the second in raising the fascines out of the formers down on the ways and tied them together. When the ways were filled, the friction brakes were raised and the launch made, the brakes being put on again just before the launch was completed, so as to get a uniform strain on each cable.

In order to strengthen the mat, five longitudinal wire strands, 26 feet apart, were placed over its whole length; the first one was on the outside or channel edge, and of $\frac{1}{2}$-inch diameter, composed of nineteen galvanized-steel wires; the second was

also ½-inch and the remainder were ⅝-inch diameter, composed of seven wires. These strands were fastened to the head of the mat at the same places as the other strands, and were clamped to the weaving strands at every tenth fascine, the clamps being so arranged as to come half way between those on the bottom of the mat.

The shackle straps were fastened to the mat by first taking a turn around the head, then encircling two or three fascines about 10 feet from the head, and then clamping to the top strands. Seven shackle straps were used, the two nearest the shore not being backed up with top strands.

In order to give the mat the necessary rigidity in sinking, longitudinal poles of 3 to 8 inches diameter at the butts were placed over it, the rows being 13 feet apart, and were fastened to the mat with No. 12 galvanized wire and No. 9 copper wire. The ties were 4 feet apart, one of copper and the next two of galvanized wire. These wires encircled a fascine and a pole. Care was taken to keep the galvanized and copper wires well apart so that no chemical action could take place and destroy the wires.

At first the progress of construction was slow, owing to the fact that the labor was untrained and that the fascine mat was an experiment, but after the details had been worked out fairly good progress was made.

Mattress construction was begun on July 27 and completed on August 16, when the mat was sunk. Its dimensions were 900 by 250 feet, 2,250 squares (of 100 square feet).

Brush used per square	cords..	1.60
Poles used per square	do...	.05
Stone, ballasting	cubic yards..	.57
Total cost of mat per square		$6.25

Grading.—There was not a very large amount of grading to be done, as the bank had nearly a 1 on 3 slope, excepting at the upper end, where the graders had to be used. Hydraulic grading began on August 17 and was completed August 25. The graders used were No. 40 and pile-driver No. 20, the same as employed at Hopefield Bend, Ark., during last season.

Bank graded	linear feet..	360
Material moved	cubic yards..	2,154
Cost per cubic yard	cents..	8

The excessive cost was due largely to a pile of very compact sawdust, which was removed with difficulty

Connecting mattresses.—Narrow connecting mats were placed along the entire bank, protected, as the river mat did not come up to the water's edge. These were built on the ways, and were of the old type of mattresses, and then launched in place.

Total length of connecting mats built, including laps	linear feet..	1,000
Average width of connecting mats	feet..	15.55
Total built, 155.5 squares (100 square feet)	square feet..	15,550
Brush and poles used per square of mat	cords..	4
Stone (ballast and sinking) per square of mat	cubic yards..	2.50
Cost per square foot in place	cents..	15.63

The quantity of stone used was large, as an extra amount was placed on the mat from the zero to the 10-foot contour.

Paving.—Preparatory to paving the grade was neatly dressed. Paving began at or near the 8-foot contour and extended to the 27-foot contour. The spalls used in paving were from 1 to 10 pounds in weight and stone from 10 to 40 pounds. The average thickness of paving was 10 inches, 4 inches of spalls and 6 inches of riprap.

Linear feet of bank paved was 900; square feet of bank paved was 72,008—8,001 square yards.

Total cost exclusive of grading, 8.36 cents per square foot.

SUMMARY.

	Per linear foot.
River mat, 900 linear feet, 2,250 squares, cost	$15.62
Connecting mats, 900 linear feet, 155.5 squares, cost	2.32
Paving, 900 linear feet, 72,008 square feet, cost	7.58
Sundries (superintending care of plant and repairs)	2.26
Total cost, per linear foot	27.78

Nine hundred linear feet of revetment cost $25,000.

Accompanying this report is a tabulated statement showing expenditures in detail. The plan showing location and dimensions of the work has been sent to the office.

Respectfully submitted.

WM. GERIG,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Statement of expenditures at New Madrid, Mo., from July 1 to August 31, 1893.

Items	Superintendence.	Care of plant.		Repairs to plant.		River mat	
		Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Labor	$545.13	.....	$220.81	.....	$227.44	.....	$3,421.68
Subsistence service	11.24	.....	18.32	.....	11.17	.....	108.67
Subsistence stores	41.79	.....	67.64	.....	42.90	.....	460.76
Brush ..... cords	.....	.....	.....	.....	.....	3,460.5	3,501.27
Poles ..... cords	.....	.....	.....	.....	.....	134.5	208.55
Stone ..... yds	.....	.....	.....	.....	.....	1,277.5	2,551.68
Wire, copper ..... lbs	.....	.....	.....	.....	.....	1,908	261.40
Wire strand steel ..... lbs	.....	.....	.....	.....	.....	24,792	1,290.86
Coal	.....	.....	8.47	.....	.....	.....	.....
Piling ..... ft	.....	.....	.....	.....	.....	46.3	19.66
Lumber ..... ft., B. M	.....	.....	.....	.....	38.37	.....	.....
Spikes and nails ..... lbs	.....	.....	.....	300	5.40	1,000	27.40
Staples ..... lbs	.....	.....	.....	.....	.....	23	3.63
Clips ..... No	.....	.....	.....	.....	.....	3,713	407.17
Manila rope ..... lbs	.....	.....	.....	.....	.....	1,119	100.38
Iron and steel ..... lbs	.....	.....	.....	142	4.26	.....	.....
Oakum ..... lbs	.....	.....	.....	200	13.72	.....	.....
Paints	.....	.....	.....	.....	2.00	.....	.....
Oils and engineers' supplies	.....	.....	33.50	.....	12.00	.....	2.30
Ice ..... lbs	5.00	1,200	5.00	.....	5.00	4,800	20.00
Miscellaneous	.....	.....	5.00	.....	9.73	.....	9.00
Total	603.16	.....	358.74	.....	371.99	.....	12,333.93

Items	Bank revetment.				Connecting mats.		Towboats.	Miscellaneous.	Total.
	Hand grading.	Hydraulic grading.	Paving bank.		Quantity.	Cost.			
			Quantity.	Cost.					
Labor	$485.44	$172.34	.....	$1,009.17	.....	$449.02	$1,122.13	$317.01	$7,970.17
Subsistence service	3.62	12.50	.....	20.77	.....	15.79	122.70	10.99	335.17
Subsistence stores	13.45	46.79	.....	79.83	.....	60.76	289.04	41.26	1,083.73
Brush ..... cords	.....	.....	.....	.....	626.5	657.82	.....	.....	4,159.09
Poles ..... cords	.....	.....	.....	.....	13.2	20.00	.....	.....	229.55
Stone ..... yds	.....	.....	2,454.3	4,902.65	400	799.00	.....	.....	8,253.33
Wire, copper ... lbs	.....	.....	.....	.....	.....	.....	.....	.....	261.40
Wire strand steel, lbs	.....	.....	.....	.....	1,765	75.92	.....	.....	1,366.78
Coal	.....	40.25	.....	.....	.....	.....	512.50	.....	561.22
Piling ..... ft	.....	.....	.....	.....	.....	.....	.....	.....	19.66
Lumber ..... ft., B. M	.....	.....	.....	.....	.....	.....	3.75	.....	42.12
Spikes and nails .. lbs	.....	.....	.....	.....	.....	.....	.....	.....	32.40
Staples ..... lbs	.....	.....	.....	.....	.....	.....	.....	.....	3.63
Clips ..... No	.....	.....	.....	.....	.....	.....	.....	.....	407.17
Manila rope .... lbs	.....	.....	.....	.....	.....	.....	.....	.....	100.38
Iron and steel .. lbs	.....	.....	.....	.....	.....	.....	.....	.....	4.26
Oakum ..... lbs	.....	.....	.....	.....	.....	.....	.....	.....	13.72
Paints	.....	.....	.....	.....	.....	.....	.....	.....	2.00
Oils and engineers' supplies	.....	18.00	.....	.....	.....	.....	.....	.....	65.80
Ice ..... lbs	5.00	2.00	2,100	8.94	2,400	10.00	.....	.....	60.94
Miscellaneous	.....	.35	.....	.....	.....	.....	3.39	.....	27.47
Total	507.51	292.28	.....	6,021.36	.....	2,088.31	2,053.51	369.26	25,000.00

River mat, 900 by 250 feet, 2,250 squares ..... per square.. $5.25
Connecting mat 15,550 square feet ..... per square foot.. 0.1563
Bank revetment, 72,008 square feet ..... do.... 0.0947
Total revetment ..... per linear foot.. 27.78

APPENDIX 2 B.

REPORT OF ASSISTANT ENGINEER AUG. J. NOLTY ON OPERATIONS AT PLUM POINT REACH.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., March 1, 1894.

CAPTAIN: I have the honor to submit my report of operations at Plum Point Reach for ten months ending with January —, 1894.

At the beginning of the period covered by this report the only field work in progress was the sinking of test holes in the bank at Mud Point, Ashport Bend.

It will be remembered that this piece of bank proved very troublesome during construction of revetment work last season by reason of sliding and subsidence of large blocks, so that the revetting of this portion of the bank was finally postponed to the period of extreme low water. Four holes were sunk here. The location of these is shown on the accompanying progress sheet, and sections are appended hereto.

The boring party consisted of 1 foreman and 6 laborers. The holes were started with a 4-inch casing, which was driven down from 90 to 115 feet, or as long as reasonably good progress was made, preference being given to the large casing on account of the large gravel frequently encountered, which entered more readily into the 4-inch sand pump. A 2½-inch casing was then driven down to the required depth. When large gravel was encountered with the small casing an ordinary stone drill was sent down to break this up, so that it would enter the smaller sand pump. The advance end of each casing had screwed to it a case-hardened sleeve, whose end had coarse teeth filed into it, thus making a hollow reamer out of it. This was found of great advantage, especially when buried timber was met. Driving down the pipe was at first tried, but soon abandoned, as it was found that the threads at the pipe end suffered severely from driving. The method then adopted was to frequently revolve the pipe, and to facilitate penetration a removable platform was built upon the pipe, and about a ton of stone placed upon this. The platform could be quickly taken down and put up when additions to the pipe were made. The penetration of the holes was as follows, viz: No. 1, 164 feet; No. 2, 110 feet; No. 3, 166 feet; and No. 4, 168 feet.

Work was begun on March 22 and completed on July 6, giving a total working time of 840 hours. This gives 1 foot penetration for every 1.38 hours' work of the party. No special difficulties were met with and no pipe or tools lost. The cost of this work will be found in the statement of cost of work accompanying this report.

Storage of stone.—At the close of the previous season's work there remained stored at Ashport Bend 2,669 cubic yards of stone and 500 of spalls. Deliveries of stone for the season began on the 26th of April, when the Huntington and St. Louis Towboat Company sent their first tow. A quarter boat was at once sent to the place of storage and an unloading party organized. The work of unloading continued until September 1, after which the stone was used on the works as fast as received. Stone was furnished by the Huntington and St. Louis Towboat Company and by Irwin & Burke. The first-mentioned firm delivered the stone at the works on their own barges, while the latter loaded it on United States barges, the towing being done by our own towboats. The total amount of stone received during the season is as follows, viz:

	Cubic yards.
Huntington and St. Louis Towboat Company:	
Limestone riprap	18,295.64
Sandstone riprap	10,879.77
Sandstone spalls	799.60
Limestone spalls	5,279.81
Irwin & Burke:	
Limestone riprap	21,994.15
Limestone spalls	1,940.40
Total receipts	59,188.37

There remains on the bank at Ashport Bend 600 cubic yards of stone. Barge No. 212, while in tow of the *Osceola*, was sunk at Cherokee Crossing, and the barge, together with its load of stone, proved a total loss.

There was furnished the Gold Dust Dam party from the depot at Ashport Bend 4,190 cubic yards, and to the Bullerton revetment party 17,286 cubic yards. The cost of towing 23,934 cubic yards from the quarries at Apple Creek to the depot was $7,373.80, which is equal to $0.3088 per cubic yard. There were unloaded on bank 41,000 cubic yards at a cost of $0.1680 per cubic yard, and there were reloaded on barges 43,566 cubic yards at a cost of $0.306 per cubic yard. There were therefore handled 83,566 cubic yards at a cost of 24 cents per cubic yard. In this cost is included labor, subsistence, repairs to wheelbarrows, care of plant, and the nec-

essary towing. The cost of reloading is much higher than that of unloading, because stone is usually received at a high stage of river and consequently the wheel is short, whereas the loading back on to barges is necessarily done at a low stage of river and the wheel is proportionately longer. All stone was broken up so that no piece exceeded 40 pounds in weight. Thirty-four thousand cubic yards were thus sledged at a cost of 6 cents per cubic yard. Two thousand three hundred and seventy-three dollars paid for rent of barges has been charged to stone. The price of stone, cost of towing, cost of handling, cost of sledging, and rent of barges has been added together, and from this sum the cost per cubic yard, which is $1.7262, obtained.

CONSTRUCTION FLETCHERS BEND.

During the high water of 1892 section B of the Fletchers Bend revetment suffered considerable damage at its juncture with section A. The former revetment was constructed in 1888, but it was not until 1891 that the 4,400 feet of unprotected bank above was revetted. In the meantime active caving caused the bank line to recede so that when the two sections were finally joined the place of juncture became a sharp salient acting as a deflecting dam, causing a strong current along the outer edge of the old mattress and a violent eddy along shore below the point. The result was a total destruction of about one-half of section B.

It had been contemplated to repair this fault in 1892, but no plant being then available repairs had to be postponed.

Work was begun here on August 9 by driving the abutment and doing other preliminary work. Mattress construction was begun on the 16th of the same month and on the 26th the mattress, which was 595 feet long by 250 feet wide, was sunk. This mattress was of the fascine type and was the first large one of that kind constructed on Plum Point Reach. At the head of this mat and along the outer half for its entire length, the current was very strong, while inshore there was an equally strong one in a reverse direction. The downstream end of the mattress was therefore securely anchored with one 2-inch and two 1¼-inch lines. This was done to prevent any upstream movement during sinking. The latter operation was as usual begun at the upstream end and proceeded nicely for two-thirds of its length, when the mat began to move upstream successively parting the 2-inch and one of 1¼-inch lines. The mat buckled badly near shore, two folds being visible after the mat was sunk, but the other half of it did not appear to be disturbed as it was outside of the influence of the eddy. The depth of water in the middle of the pocket was 101 feet below zero. Owing to the concavity of the pocket a supplemental mat 124 and 477 feet long had to be constructed to connect the river mat with the bank. This mat was made long enough to fully cover the part of the bottom left exposed by the upstream movement of the main mat. The supplemental mat was sunk in inverse order (from the downstream end up), and went down in perfect shape. The ill success attending the sinking of the main mat, and which was due to an error of judgment in underestimating the force of the reverse current, is the first instance of unsuccessful sinking that has occurred here since 1885.

Ashport Bend.—Two of the four spur dikes at Mud Point were incomplete at the close of the last season's work as the river was then not high enough to extend them the proper distance inshore. On March 11 one pile-driver and crew, together with the requisite material, were sent there to finish this work. They completed the work on the 25th. Although the dikes do not extend outstream as far as originally contemplated no further work will be necessary here, as the eddy is now pretty well broken up by the existing works, and no further subsidence or sliding of the bank has taken place since the revetment was put in.

While the storage of stone was in progress some of the unfinished shore paving at Mud Point and at section 8*a* that could not be completed the previous season on account of running ice and high water, was carried up to the proper height as soon as the stage of river was favorable for this work.

Upon subsidence of the last high water extensive damage to the previous season's work was noted. The faults were as follows: 77+85 to 80+40, a distance of 255 feet, the shore work was entirely destroyed and the inner edge of connecting mat somewhat damaged. From station 86+50 to 89+10 the shore work was destroyed. At the former place the shore cables had parted and the anchor piles were out of perpendicular, all leaning somewhat outstream, and this would indicate that the connecting mat had slid down the slope away from the paving, thus leaving a zone of bare bank exposed to erosive action. On account of ice and high water it was impossible to construct a connecting mat and do the necessary paving at the latter place. In neither case were the river mats damaged. The next, and by far the most serious, damage was from station 98 to 115+20, a distance of 1,720 feet. Here the entire shore protection had either disappeared or was so badly disintegrated as to make its removal necessary. Referring to the progress sheet it will be seen that the sections involved are 8*b* and 5. It will be remembered that between the foot of the

former section and head of the latter there had been left a gap of 100 feet without any subaqueous mat and 150 feet without shore work. The initial damage was done here and the caving worked upstream about 400 feet but very little downstream. The destruction of section No. 5, where the river mattress was only 200 feet wide, was plainly due to undermining along the outstream edge of the mat and the consequent sliding down of the main and connecting mats. Reference to the progress sheet will show that the inner edges of the connecting mats rested on the slope from the 5-foot to the 12-foot contour, as the river was quite high when they were constructed. At the last low water there was visible only a part of the edge of the highest one of these, and that had apparently assumed a nearly vertical position. All shore cables had parted.

The location of least width of river at the time of construction in 1892 was a little below Mud Point, but during the high water of 1893 the point of the opposite sand bar moved downstream to about opposite the head of section 5, greatly reducing the width of section and of course creating greater depth. When the soundings taken in August, 1893, are compared with those taken after the mat was sunk the previous year it will be seen that the depths along the outer edge of this mat have increased by from 35 to 55 feet. The later soundings show settlement over the entire width of mat, the maximum being of course along the outer edge. The river mats are still here but in what shape could only be determined by a diver.

As it was evident that wider mattresses would be required a standard width of 300 feet was adopted for all subsequent work. Some doubts as to the flexibility of the woven mats having been created the fascine type was adopted. The greater flexibility of this type it is believed will allow it to quickly follow any undermining and check it before it becomes serious enough to damage the work.

River mat No. 9.—Actual construction of this mat was begun on the 6th of September, upon which day the outfit was swung into position for building. No stumps or standing timber suitable to fasten the shackle and mooring cables to being found, "dead men" had to be planted. This mat was sunk on the 23d. Its head lies at station 121+13; dimensions, 1,119 feet long and 300 feet wide; maximum depth of water, 53 feet below zero. Its inshore edge rested on the bank for nearly its entire length. Near the head there was a deep pocket, and here 354 linear feet of connecting mat had to be placed so as to make proper connection with the subsequent shore paving.

River mat No. 10.—The plant for this mat was swung into position on September 26. Its head lies at station 115+16, or 40 feet above the foot of mat No. 5 (1892). Its length is 658 feet and width 300 feet. It laps mat No. 9 25 feet. The mat was sunk on October 6. Maximum depth 50 feet below zero. In the absence of natural fastenings "dead men" had to be used here. Three hundred and seventy-four linear feet of connecting mat had to be constructed.

River mat No. 11.—This mat was begun on the 9th and sunk on the 19th of October; maximum depth 89 feet below zero. It is 913 feet long and 300 feet wide. Its head lies at station 106+40, overlapping mat No. 10 25 feet. Owing to the deep concavity of the bank 830 linear feet of connecting mats were required here. This mat covered the greater portion of mat No. 5 (1892).

River mat No. 12.—This mat was not begun until October 25, the mattress plant in the interval between the 19th and 25th being used to construct connecting mats. No. 12 is 825 feet by 300 feet wide. Its head lies at station 98+39 and overlaps No. 11 25 feet at the foot, and at its head a good lap with the uninjured old work is made. This mat, together with the preceding one, cover all the damaged work of sections 8*b* and 5. Mat No. 12 was sunk on November 5. Maximum depth 96 feet below zero. Four hundred and forty-five linear feet of connecting mat were required here.

River mat No. 13.—This mat was begun on November 9, the interval between the 5th and 9th devoted to the construction of connecting mats. It is 1,125 feet long by 300 feet wide, its head overlapping the foot of No. 9 25 feet. It was sunk on the 23d of November. The shore along here being almost entirely free from "scallops," only 110 feet of connecting mat were required here. For the balance of its length the shore paving was started directly from the edge of the river mat. "Dead men" had to be used here for anchorages.

River mat No. 14.—Construction of this mat was begun on November 29. During the interval between the sinking of No. 13 and beginning No. 14 the entire force were employed in loading stone for the different construction parties and in bringing the shore paving up to a safe distance above an expected rise in the river. After about one-half of this mat had been completed it was found necessary to largely increase the stone loading force by drafts from the mattress gang in order to meet the large demands for stone from the other construction parties. This mat, which is 1,095 feet long by 300 feet wide, was sunk on December 12. Maximum depth 24 feet below zero. It overlaps No. 13 25 feet and terminates at station 153+40.

When the mat was begun it was found necessary to run out an anchor to hold the mooring barges in position, they showing a disposition to move upstream and swing in toward the shore, even with all the brush barges hanging to them. At first an ordinary 150-pound ship's anchor was used, but this dragging, a bursted water cylinder from one of the graders was used instead, and this held. The bank along here was straight and had a natural foot slope for its entire length, so it was expected that no connecting mats would be required, but before the mat was completed a sudden rise in the river left from 25 to 35 feet of water between the mat and shore by the time the mat was ready for sinking. Hence, as the lateness of the season did not promise with any certainty a fall sufficient to allow of the paving to be started directly from the main mat, connecting mats aggregating 1,060 linear feet were put in. The river never did go low enough by 3 feet to have allowed the omission of these connecting mats. "Dead men" were used for fastenings. No. 14 was the last of the river mats constructed during the season.

All mattresses were constructed in such order whenever practicable that the upstream one overlapped the one next below. This prevents any possible shifting of ballast and consequent rising of the head.

Hard-wood poles for the heads of river mats were at first gotten out by hired labor, and afterwards by contract at 75 cents per pole, delivered at the work. Toward the end of the season hard wood became scarce in the vicinity of the work and cypress was used.

Connecting mats.—An aggregate of 3,173 linear feet of connecting mats were constructed, varying in length from 85 to 300 feet, and in width from 35 to 90 feet, as follows: Section No. 9, 354 feet; section No. 10, 374 feet; section No. 11, 830 feet; section No. 12, 445 feet; section No. 13, 110 feet; section No. 14, 1,060 feet.

Of the above 2,233 feet were of the fascine type, and the balance, 940 feet, of the woven type. All connecting mats overlapped the river mats 20 feet, and each other at the ends 10 feet. Where more than one of these was required construction began with the one farthest downstream and proceeded upstream so that the laps would come right.

DETAILS OF CONSTRUCTION OF MATTRESSES.

As already stated all river and most of the connecting mats were of the fascine type. The length of the fascines was equal to the width of mat, and their diameter from 10 to 12 inches. In making the fascines the brush was so placed in the formers that no two butts came in the same place, and one layer of brush would have the tops in one direction, while the next layer would be reversed, the object being to have the individual fascines of uniform strength and density throughout. The bundles of brush thus formed were tied with enough single wire ties (one every 12 feet) to hold them in shape until incorporated in the mat. Sewing strands were 8 feet apart, as were also the bottom longitudinal strands. When top longitudinals were used they were so spaced as to come over the bottom one. Each sewing strand was fastened to the longitudinals at every 10 feet (at the points of intersection) with a cable clamp. Top longitudinals, which are not necessary except in very deep water or strong current, were used on mats No. 9 (3), No. 11 (6), and No. 12 (6), and on the Fletchers Bend mat (9).

Top poles were laid longitudinally every 8 feet and wired down to the mat with No. 7 silicon bronze wire every 5 feet, these ties being supplemented every 15 feet with one of four strands No. 12 iron wire. Over the two outer lines of poles short transverse ones were laid and upon these two more lines of longitudinal ones so as to make deeper pockets for the stone ballast along the outstream edge of mat. The poles are spliced together with one tie of annealed iron wire, butts and tops lapping about 5 feet.

The sewing strand passed entirely around the fascine, taking in the bottom longitudinals. This strand is $\frac{1}{4}$ inch diameter, bottom longitudinals $\frac{5}{16}$ and top longitudinals $\frac{5}{16}$, $\frac{3}{8}$, and $\frac{1}{2}$ inch, according to strength of current, or rather to the strains that the mat would be exposed to in sinking. The longitudinals are continuous for the length of mat, while the sewing strand is cut into lengths of 60 feet. The bottom longitudinals are wound on drums placed on the mat barge under the platform, and during construction are kept taut by means of weighted brakes bearing on the flanges of the drums. In launching off, the brakes are eased up until the mat is sliding freely down the ways, when they are let go. The stone ballast is evenly distributed over the mat, about one-half yard to the square. On account of the more rapid silting up of this type of mat, ballasting should not begin until the mat is finished. About one-half yard of stone per square is required for sinking. Where the current is reasonably strong somewhat less will sink the mat, as the current aids the mat in sinking. The tabulated statement forming part of this report will give further information as to the quantities of the various materials entering into the construction of a unit of mat.

The total length of river mat constructed at Ashport Bend is 5,735 linear feet; length of bank protected, 5,510 linear feet. The excess of length of mat over length of bank is due to laps of the different mats, and also by the mattresses following the meanderings of the shore, while the length of bank is measured on a straight line.

The following shows the daily average of mattress construction for the season and for each mat; also the equivalent for each day's labor for the season and for each mat. It will be seen that there is a steady increase in the results of labor as the season advanced. The decrease in the daily average for mat No. 12 was due to a smaller force being employed on that mat. In the labor is included every kind of work connected with the construction of mattresses. The best day's work was toward the close of the season, when 160 linear feet of 300 feet wide mat was made with 246¾ days' labor.

Total days worked on construction of river mats	61
Total length of mattress made.....feet..	5,735
Average linear feet made each working day	94
Days worked on mat No. 9	15
Average linear feet per day	74.6
Days worked on mat No. 10	8
Average linear feet per day	82.2
Days worked on mat No. 11	9
Average linear feet per day	101.4
Days worked on mat No. 12	9
Average linear feet per day	92
Days worked on mat No. 13	11
Average linear feet per day	102.3
Days worked on mat No. 14	10
Average linear feet per day	109.5
Total days' labor on construction of river mats	13,028
Average linear feet per day's labor	.44
Days' labor on mat No. 9	2,900
Linear feet per day's labor	.386
Days' labor on mat No. 10	1,554
Linear feet per day's labor	.43
Days' labor on mat No. 11	2,091
Linear feet per day's labor	.436
Days' labor on mat No. 12	1,840
Linear feet per day's labor	.448
Days' labor on mat No. 13	2,433
Linear feet per day's labor	.462
Days' labor on mat No. 14	2,210
Linear feet per day's labor	.495

Grading.—This work invariably followed the sinking of river and connecting mats, and thus the trouble and delay and increased cost always encountered when grading was attempted in advance of the mattress work has been entirely eliminated. The same slope used last season, namely, 3 to 1, was adopted. Where projecting points between two adjacent scallops were met the slope was necessarily flatter. The grading was not carried higher than the 20-foot stage, a wall of from 8 to 10 feet being left standing. Hydraulic graders Nos. 2 and 4 and pile-driver No. 19 were used, the latter, however, only before actual operations were begun for regrading section 8*a* and part of 8*b*, where the shore paving had not been completed the previous season, and the slope had to be redressed before the paving could be furnished.

Grader No. 2 worked the entire season, seventy-four working days, without a single breakdown, and made an excellent record. Grader No. 4 worked here fifty-three days. Soon after this machine was put in commission the piston rings of the water end of the air pumps gave trouble and one of these pumps soon became unserviceable. As we had similar trouble last year, and as the only remedy for this would be to reduce the width of ports in the cylinder or increase the width of the packing rings so that they could no longer spring into the ports, it was decided to abandon the condenser and work the pumps noncondensing. No further trouble was experienced and this grader did good work. No. 4 was sent to Bullerton Tow-Head on the 27th of November, where it worked the balance of the season. Three jets were worked from each machine, the diameter of nozzles on No. 4 being seven-eighths inch, and those of No. 2 were two 1-inch and one 1¼-inch. Three-inch and 4-inch 8-ply hose were used. Steam pressure, 100 pounds; vacuum, 25 inches; water pressure, 170 pounds; average daily consumption of coal, 80 bushels. The daily rate of progress in loose soil free of stumps averaged 75 feet, while in tough blue clay, or

where many stumps were encountered it fell as low as 25 feet. The volume per linear foot of cut averaged 27.2 cubic yards.

Paving.—As soon as a section was graded shore paving was laid in zones 10 to 15 feet wide, measured up the slope. An exception to this was made at section No. 13, where advantage was taken of a natural foot slope to start the paving directly from the mat up a short distance before grading. The paving was carried farther up the slope from time to time, advantage being taken of any rise in the river, as every foot increase in the elevation of water surface shortened the wheel.

At sections Nos. 11 and 12 the paving was carried up to the 20-foot stage, as this part of the work will be exposed to more severe strains than any other. At sections Nos. 9, 10, and 13 the paving was carried up to the 17-foot stage, while at section 14 it terminates at the 15-foot stage. All riprap was laid on a 4-inch foundation of spalls.

Rain gullies were closed with spalls to prevent damage from washouts.

As the demand for stone became heavy, most of the spalls and stone used on section No. 12 and about one-half of that used on No. 11 was hauled to place by teams. This part of the work was close to the storage piles, and by using teams the paving could be continued without overtaxing the loading party. Three dollars per day was paid for teams. Teamsters were paid by the owners of teams, but subsisted without charge by the United States. Maximum length of haul, 2,200 feet; number of cubic yards stone hauled, 2,876; total team days, 132.75; cost, including subsistence of teamsters, $442.14; cost hauling one cubic yard, 15.37 cents.

As already stated, a 4-inch layer of spalls is first spread on the slope and the stone is laid on this. The thickness of the latter is 12 inches at the low-water line tapering to 8 inches at the top. The stone is edged up, the pitch being increased as the thickness is diminished. Stone from ledges not more than 6 inches thick makes the best paving.

Repairs to existing works.—The faults in the 1892 work already mentioned were repaired by laying floor mats and, where necessary, supplementing these with connecting mats to connect the former with the dry bank. The floor mats were so constructed that they overlapped the subaqueous ones at least 25 feet, and were fitted as close as possible to the pockets.

All mat work done here was of the woven type, as the amount of brush on hand was not sufficient to permit the other type to be used. After the mattress work was completed a fringe of stone was laid around the edges of pockets wherever lodgment for it could be found, and, in addition, there was piled around the pockets on top of bank and 6 feet distant from the edges 250 cubic yards of stone for each one. No grading was done here, and it is believed that, should further caving take place, the stone caving in with the bank will form a rough paving sufficiently close to check any deep or extensive caving.

About 200 cubic yards of stone was expended at the foot of the 1891 work and at Mud Point to prevent the enlargement of gullies in the bank above the shore paving.

Miscellaneous work.—A large amount of work incident to construction was done. This comprises construction of abutments for the various river mats, getting out hard-wood poles for the mattress heads, planting "dead men" for the anchorages, clearing bank in advance of the grading party, building roads for haulage of stone, cutting wood for use in bake shop, coaling plant, care of plant, removing wreckage of old work from bank, etc.

The Jutte Coal Company having lost a boat of coal at Woodloes Pocket, and the conditions being favorable for the recovery of most of this, a small party was sent up there on September 26. Their outfit consisted of one pile-driver converted into a quarter boat, one pile-driver for washing the coal, one small flat, and the necessary hose, barges, etc. They worked there twenty-six days and recovered 21,339 bushels of coal at a cost of 7.18 cents per bushel, delivered. This includes $400 paid the owners for the coal.

General remarks.—At the beginning of the season's work laborers' wages were fixed at 80 cents per day for the first month's work, 90 cents for the second month, and so on up to $1.20 for the fifth month; the work to be continuous to entitle the man to the benefits of this scale. Loss of time through actual sickness or injury sustained while on duty did not operate against the man. The object of this sliding scale was to encourage good men to remain on the work for the season. That this object has been attained, and that thereby more efficient labor has been secured, a glance at the table will show. Near the close of the season's work, before any material reduction was made in the force, there were 145 laborers receiving the highest rate of pay out of a total of 308.

The cost of towing brush has been 26.8 cents per cord. Scarcity of barges in the early part of the season and frequent removals of the contractors' camps have had a tendency to slightly increase the cost. With plenty of barges, so that the boats can be loaded to their full capacity on each trip, the cost will not exceed 25 cents.

Construction at Ashport Bend closed for the season on January 22 of the current year, and the plant still remaining there was moved down to Elmot Bar, where two days were spent with a small force putting in a small spur dike to prevent the undermining of the shore work on the bar side of the Gold Dust Dam. Two hundred and four yards of stone and spalls were used here.

On the 25th the plant was towed to the winter harbor at Memphis. Transmitted herewith is a statement of the kinds and amount of work done during the season, a table showing the cost per unit of this and last season's work, together with the total cost, and a statement of materials expended.

Following is a summary of work done during the season:

At Fletchers Bend:		
Abutment driven		1
River mat made and sunk, 595 by 250 feet	squares..	1,487.5
Supplemental mat made and sunk, 477 by 124 feet	do....	581.5
Connecting mat made and sunk, 124 by 50 feet	do....	62
Paving, 475 by 9 feet	square yards..	475
At Ashport Bend (new work):		
Abutments driven		6
River mat made and sunk, 5,735 by 300 feet	squares..	17,205
Connecting mats made and sunk (300 by 57.5, 300 by 35, 300 by 40, 160 by 50, 104 by 50, 300 by 44, 104 by 55, 320 by 62.5, 250 by 47.5, 290 by 80, 300 by 70, 155 by 90; total, 3,173 feet)	squares..	1,755.25
Grading (5,691 linear feet)	cubic yards..	154,795
Paving (5,580 linear feet)	square yards..	34,330
Test holes bored	feet..	608
Piles driven		64
Stringers put up		8
Braces put up		32
Stone unloaded	cubic yards..	41,000
Stone loaded on barges	do....	43,000
Stone sledged	do....	34,000
Repairs to existing works:		
Floor and connecting mats made and sunk	squares..	539.5
Grading (540 linear feet)	cubic yards..	3,400
Paving (1,282 linear feet)	square yards..	7,265
Stone placed around pockets	cubic yards..	500
Gold Dust Dam:		
Stone spur dam built	cubic yards..	204

Respectfully submitted.

AUG. J. NOLTY,
Assistant Engineer

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

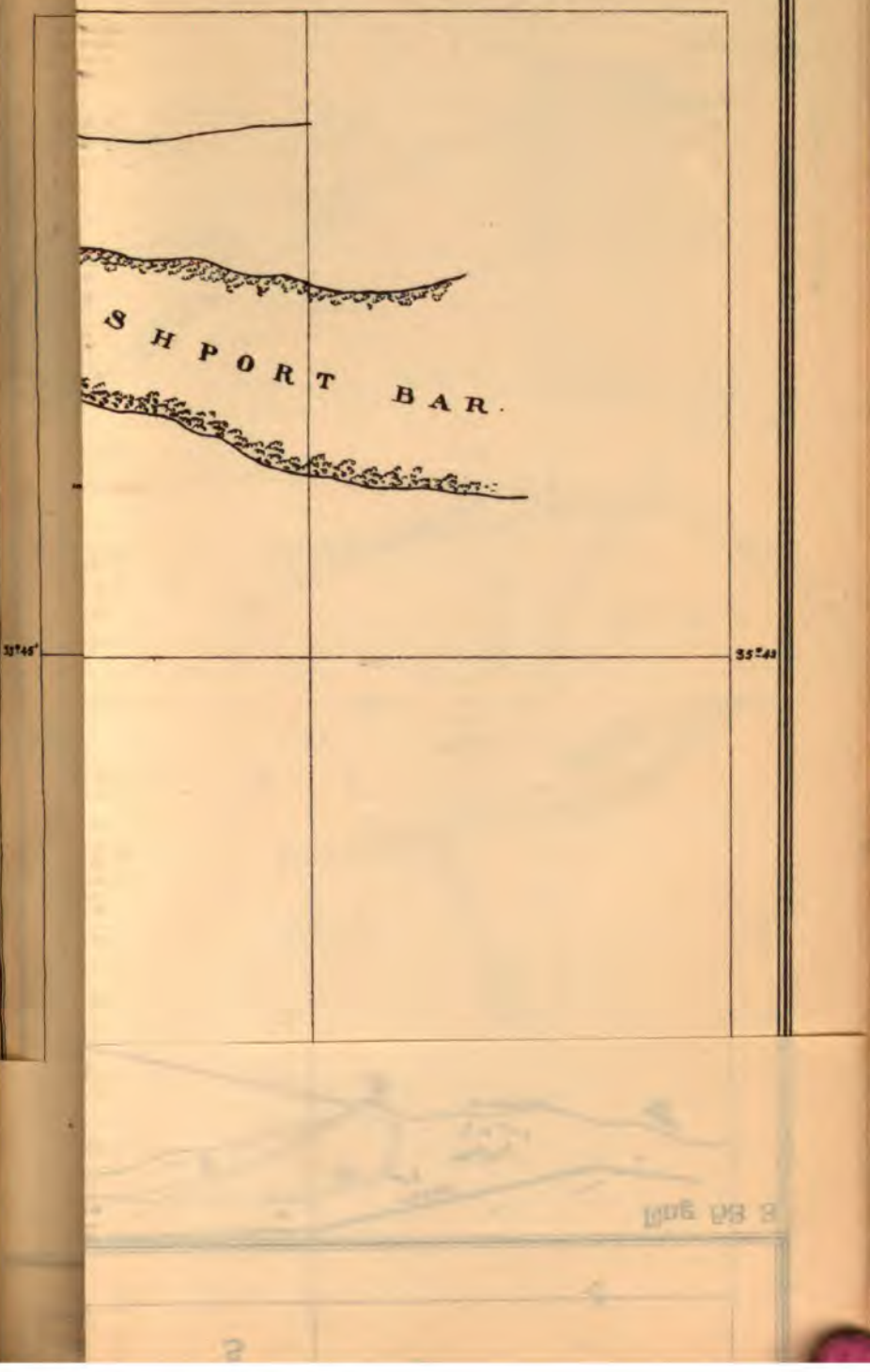
Abstract of expenditures from April 1, 1893, to January 31, 1894.

CONSTRUCTION ASHPORT BEND.

Kind of work.	Brush.		Poles.		Piling.		Coal.		Spikes	
	Cords.	Cost.	Cords.	Cost.	Feet.	Cost.	Bushels	Cost.	Pounds	Cost.
Dike No. 1					4,170	$217.42	115	$11.50	89	$2.06
Dike No. 2					1,940	108.43	30	3.00	27	.63
River mat No. 9	5,177	$5,425.85	146	$218.50	340	14.88				
River mat No. 10	2,692	2,805.45	71	106.50	128	5.44				
River mat No. 11	4,231	4,870.01	119	178.50	168	7.14				
River mat No. 12	3,778	4,416.65	79	118.50	300	12.74				
River mat No. 13	5,218	5,478.90	144	216.00	200	8.50				
River mat No. 14	4,503	4,728.15	144	216.00	270	11.48				
Connecting mat, section 9	433	454.65								
Connecting mat, section 10	522	548.10	5	7.50						
Connecting mat, section 11	794	833.70	14	21.00						
Connecting mat, section 12	692	726.60								
Connecting mat, section 13	155	162.75	4	6.00						
Connecting mat, section 14	1,083	1,137.15	15	22.50						
Grading							12,200	1,220.00		
Miscellaneous work							205	20.40		
Preservation of work	1,140	1,155.82	148	200.94			225	22.50		
Care of plant							975	97.50		
Total	30,518	32,743.78	889	1,311.94	7,516	386.03	13,749	1,374.90	116	2.69

Kind of work.	Wire, strand.		Wire, iron.		Wire, galvanized		Staples.		Iron.	
	Pounds	Cost.	Pounds	Cost.	Pounds	Cost.	Pounds	Cost.	Pounds	Cost.
Dike No. 1	1,306	$53.58								
Dike No. 2	275	11.30								
Experimental borings									2	$0.05
River mat No. 9	34,403	1,393.44			12,391	$299.87	624	$13.98		
River mat No. 10	22,229	834.26			9,363	210.03	356	797		
River mat No. 11	30,056	1,101.48	5,200	$96.40	10,478	230.73	509	11.40		
River mat No. 12	23,176	810.77	7,799	14.870	9,305	205.98	460	10.20		
River mat No. 13	33,935	1,224.55	16,065	296.28	653	15.67	628	14.06		
River mat No. 14	30,223	1,195.90	10,087	188.15	2,204	52.68	611	13.68		
Connecting mat, section 9	2,314	100.20	4,999	92.68	728	14.48	37	.83		
Connecting mat, section 10	2,289	106.89	5,060	93.81	922	19.38	50	1.12		
Connecting mat, section 11	1,530	64.11	5,838	109.67	877	18.07	68	1.52		
Connecting mat, section 12	4,227	149.54	6,147	116.51			60	1.37		
Connecting mat, section 13	669	19.76	5,100	94.55	539	12.58	18	.40		
Connecting mat, section 14	4,905	177.31	4,852	90.17	1,652	41.79	93	2.07		
Grading									60	11.50
Miscellaneous work			5,000	92.70						
Preservation of work	53	1.69	4,311	80.16	723	17.36				
Total	191,590	7,244.78	80,458	1,499.78	49,835	1,138.62	3,514	78.60	62	11.55

PLATE I.



Abstract of expenditures from April 1, 1893, to January 31, 1894—Continued.

CONSTRUCTION FLETCHERS BEND.

Kind of work.	Brush.		Poles.		Piling.		Coal.		Spikes.	
	Cords.	Cost.	Cords.	Cost.	Feet.	Cost.	Bushels	Cost.	Pounds	Cost.
River mat	2,303	$2,416.85	104	$155.48	300	$12.75	139	$13.90	10	$0.24
Supplemental mat.	760	786.50	122	183.00	.....	.....	52	5.20	.....	.....
Connecting mat.	82	86.00	27	40.50	.....	.....	.....	.....	.....	.....
Total	3,145	3,299.35	253	378.98	300	12.75	191	19.10	10	.24

Kind of work.	Wire, strand.		Wire, silicon, B.		Staples.		Iron.		Wire, galvanized.		Rope.	
	Lbs.	Cost.	Lbs.	Cost.	Lbs.	Cost.	Lbs	Cost.	Lbs.	Cost.	Lbs.	Cost.
River mat	16,847	$796.84	929	$157.93	220	$4.92	145	$14.70	8,400	$200.41	1,209	$84.63
Supplemental mat.	4,789	212.39	364	61.88	114	2.55	.....	.....	659	41.79	.....	.....
Connecting mat.	446	17.57	51	7.65	.....	.....	.....	.....	184	3.98	2,247	200.00
Total	22,082	1,026.80	1,344	227.46	334	7.47	145	14.70	9,243	246.13	3,456	284.63

Kind of work.	Stone.		Clamps.		Miscellaneous materials.	Oils and supplies.	Towing.	Subsistence.	Labor.	Total.
	Cubic yards	Cost.	Number.	Cost.						
River mat	1,495	$2,580.67	2,640	$271.77	$5.38	$3.40	$952.08	$767.14	$2,456.74	$10,895.83
Supplemental mat.	659	1,137.57	950	104.07	3.00	5.30	376.00	383.01	999.54	4,311.80
Connecting mat.	184	317.62	46	4.90	.....	.....	71.50	47.96	117.39	715.62
Miscellaneous work	.....	.....	.....	.....	19.50	.....	.....	10.95	28.83	259.28
Total	2,338	4,035.86	3,636	380.74	27.88	8.70	1,399.58	1,209.06	3,602.50	16,181.93

APPENDIX 2 C.

REPORT OF ASSISTANT ENGINEER CHARLES LE VASSEUR ON CONSTRUCTION OF DAM ACROSS ELMOT CHUTE, NEAR GOLD DUST, TENN.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., March 29, 1894.

CAPTAIN: I have the honor to submit a report of the operations at Gold Dust, Tenn., from August 9, 1893, to January 6, 1894.

The object of the work was the construction of a dam of brush and stone in the Elmot Chute to a height of 16 feet above the zero contour line. A comparison of the survey of said chute of September, 1892, with that of August, 1893, shows that changes had occurred in the chute. (See Pl. II, accompanying this report.)

The changes were as follows:

The deep depression existing from station 1 to station 4 (1.5 feet in depth below zero contour) was filled up by deposit of fine and black sand to a level 5 feet above zero.

From station 4 to station 17 the bed of the chute was scoured an average of 3 feet, and from station 17 to station 29, near Tennessee shore, the existing depression below zero was filled up with black sand deposit to an average of 3 feet above zero.

These changes obliged me to modify the project submitted and approved in the following manner:

Instead of building small mats 100 feet long, 50 feet wide, 2½ feet thick on ways, floated into position, ballasted, and sunk in the deep depression near each shore, the mats were built directly on the ground of chute and made continuous from end to end of dam, without ballasting between.

Additional foot mats, 1,000 feet long, 35 feet wide, on the Tennessee side, 220 feet long, 300 feet wide, and 400 feet long, 35 feet wide on the Elmot Bar side, were built downstream to prevent the caving of the dam from downstream undermining by scouring action of falling water.

The method of operations comprised five parts:

1. Preliminary works.
2. Distribution of materials, brush and poles.

3. Dam construction, which will be divided into three parts—(*a*) Foot mat No. 1; (*b*) cribs; (*c*) foot mat No. 2.
4. Grading and bank revetment.
5. Ballasting and paving, including the hoisting plant and railroad construction.

1. Preliminary works.—The interval between August 9 to 30 was spent in organizing the force, getting materials in readiness, towing the plant to the site of the work; between August 21 to September 3 in grading inclines for brush hauling at Gold Dust and Elmot Bar landings, construction of roads for brush haulage and construction of permanent quarters on the Tennessee shore to accommodate 200 men. These quarters comprised three buildings—one sleeping quarters for men, one eating quarters for men, including kitchen and commissary storeroom, and one sleeping quarters for foremen.

2. Distribution of brush and poles.—In the beginning of the work brush and poles were received on Government barges at Gold Dust and Elmot Bar landings. The material was to be unloaded from barge, loaded on wagons, and hauled to the site of the work. The distance from Gold Dust landing to the dam was about 12,000 feet, and from Elmot Bar landing about 3,000 feet. The haulage was very long, slow, and expensive. After the foot mat was started, contracts were given to several parties owning brush in the vicinity of the work to furnish brush and poles delivered on the line of work.

A total of 8,499.6 cords of brush and poles was received on barges and hauled to the work at a total cost of $5,493.72, making an average cost of 64.63 cents per cord for transporting.

8,229.7 cords of brush received by river cost $1.05 per cord, which, with cost of transportation to work and overhaulage added, makes an average cost of $1.7502 per cord.

269.9 cords of poles received by river cost $1.50 per cord, and, with cost of transporting same to work, makes an average cost of $2.1463 per cord.

8,103.9 cords of brush were received from sundry parties and delivered on the work, at an average cost of $1.5645 per cord.

1,212.3 cords of poles were received from sundry parties, delivered on the work at an average cost of $1.4851 per cord.

3. Dam construction—(a) Foot mat No. 1.—Previous to the construction of the foot mat, layers of brush varying from 6 inches to 2½ feet in thickness were laid parallel to the current the entire width of the dam, in deep pools of water existing near the two shores, and also at several other places along the dam line, where soft material, nearly quicksand, was found. This to prevent the foot mat and dam from sinking unevenly at said places. (See Pl. VI.) The construction work started September 1. The foot mat is composed of:

(1) A bottom grillage of poles, 4 to 6 inches in diameter, 25 to 35 feet long, placed 8 feet apart in each direction and tied every 8 feet with wire lashing, two strands No. 12 wire.

(2) Two layers of brush, 1 foot 6 inches thick each, the first layer being placed longitudinally, the second laterally. These layers were composed of brush 4 inches in diameter at the butt and 25 to 35 feet long. Willow and cottonwood brush were used indiscriminately.

(3) A top grillage made of poles, placed every 8 feet in the longitudinal direction of the foot mat. The whole well compacted together, the top grillage being tied to the bottom grillage, every 8 feet each way by wire lashings, four strands No. 12 wire.

On account of the thickness of the foot mat (3 feet), and so the next crib mat would have a more regular slope on each side, the brush was placed at the up stream end of the foot mat in a step shape, as shown on Pl. III. The step so made extends 6 feet from the edge of the first layer and is composed of the first half thickness of the top layer. At the down-stream side the tops of brush of the second layer were left extending also 6 feet out of the edge of the first layer, so as to break the sudden 3-foot fall made by the total thickness of the mat. The space left between the ground and the 6-foot brush extension was filled up by loose brush placed longitudinally.

The dimensions of the foot mat No. 1 are 3,014 by 100 by 3 feet, equal to 33,488.8 cubic yards.

Material used in construction.

	Quantity.	Cost.
Brush.....cords..	6,005.6	$7,607.21
Poles.....do...	958.9	1,421.15
Wire.....pounds..	8,900	196.31
Miscellaneous materials		12.92
Total cost of materials used in foot mat No. 1		9,237.59
Cost of material by cubic yard of construction		.2757

(b) Crib mats.—The crib mats, having all the same width, 50 feet, but varying in length and thickness, were all constructed the same. The first crib mat was overlapping 8 feet upstream the edge of the foot mat, and each next crib mat was placed 8 feet higher upstream than the one below.

A crib mat is composed of:

(1) Two layers of brush, the first laid longitudinally on top pole grillage of foot mat, the second at right angle with the first and overlapping 8 feet upstream the edge of the foot mat or crib below.

(2) A top grillage, made of poles 4 to 6 inches in diameter, placed 8 feet apart longitudinally, tied together by two strands No. 12 wire, the whole being well compacted by wire lashings of four strands No. 12 wire, connecting top grillage of crib to the pole grillage under, every 8 feet each way.

The cribs were built so as to have the top surface level and not to follow the undulations given to foot mat by the bed of the chute.

Seven crib mats were built, making a total of 34,581.48 cubic yards.

Material used in their construction.

	Quantity.	Cost.
Brush.....cords..	6,858	$9,432.15
Poles.....do...	234.4	351.60
Wire.....pounds..	8,400	171.56
Miscellaneous materials.....	.....	7.97
Total cost of materials used in crib mats construction.....	.....	9,963.28
Cost of materials by cubic yard of construction.....	.....	.2881

Ballasting 4 inches thick was laid during construction only on top of crib No. 2 on the Tennessee side, from station 20 to station 29. This was done for safety on account of rising water at the time of construction.

(c) Additional foot mats.—These foot mats were built in the same manner as the foot mat No. 1, with bottom pole grillage, two layers of brush are laid longitudinally, the other transversely, and top pole grillage, the whole tied together by wire lashings four strands No. 12 wire connecting both grillages every 8 feet each way.

The connection between the foot mat No. 1 and foot mat No. 2 was made in the ollowing manner:

The bottom poles of foot mat No. 1 parallel to the current were tied to the bottom poles of foot mat No. 2 by two strands No. 12 wire. On top poles 6 inches in diameter 20 feet long were laid, half on each foot mat every 8 feet, parallel to the current and tied to poles of top grillage of both foot mats by wire lashings 4 strands No. 12 wire. (See Pl. IV.)

The dimensions of additional foot mats constructed are, 1,500 by 40 feet by 1 foot 5 inches and 300 by 250 feet by 1 foot 5 inches, equal to 7,500 cubic yards.

Materials used in their construction.

	Quantity.	Cost.
Brush.....cords..	2,420.7	$3,323.53
Poles.....do....	206.3	309.45
Wire.....pounds..	6,900	142.51
Miscellaneous materials.....	.....	5.17
Total cost of materials used in additional foot mats construction.....	.....	3,780.66
Cost of materials by cubic yard of construction.....	.....	.504

4. *Grading and bank revetment.*—The grading of bank on both sides of dam was done part by wheelbarrow and part by scrapers. Two thousand two hundred and forty cubic yards of earth were moved on the Tennessee side and 1,327 cubic yards on the Elmot Bar side.

The total of grading done is 3,567 cubic yards, at a cost of 19.6 cents per cubic yard. Total cost of grading being $679.86.

The bank revetment consists in light mattress laid extending from top of the bank to 30 feet in the chute. These mattresses were made of a bottom pole grillage; poles every 10 feet were laid on bank and tied together with 2 wire strands No. 12 wire; two light layers of brush laid at right angles, the upper layer being perpendicular to the current; and a top pole grillage, poles 10 feet apart, tied together by 2 strands No. 12 wire, the whole compacted by 4 strands No. 12 wire.

The dimensions of the shore revetment are: Elmot Bar side, 350 feet long by 100 feet wide by 1.5 feet thick; Tennessee side, 350 by 120 by 1.5 feet, equal to 4,251.84 cubic yards.

Materials used in construction of said shore revetment.

	Quantity.	Cost.
Brush ..... cords..	959.3	$1,444.75
Poles ..... do....	82.6	123.90
Wire ..... pounds..	5,930	117.83
Miscellaneous materials	.....	1.50
Total cost of materials used in shore revetment	.....	1,687.98
Cost of materials by cubic yard of construction	.....	.397

The excess in the cost of material per cubic yard noted in shore revetment and the extra foot mats over the original foot mat and crib mats was due to the range in price of brush used. The brush account being separate and distinct from cost of haulage made the brush used in the early part of the season cost $1.05 per cord, whilst that in the latter part of the season cost, delivered on work, $1.50 to $1.60 per cord. The latter brush was cheaper when the cost of transportation is added to the cost of the former as previously shown, but my accounts deal with the actual cost of the material paid the several contractors.

5. *Ballasting and paving—Hoisting plant.*—Fourteen thousand cubic yards of stone were unloaded on the two banks near the ends of the dam during high water of 1892. To distribute this stone along the dam a tramway was built on top of the brush work, and the traction of the cars was executed by hoisting engines and tail-rope system.

The tramway consisted of a double track with necessary switches (see Pl. v) laid from the end of stone piles to 1,200 feet out on top of the dam. The rails employed were 16 and 20 pound rails, spiked on cross-ties every 3 feet, and resting on wooden stringers 3 by 4 inches.

The hoisting plant at each end of the dam consisted of a boiler of 12-horse power and a pile-driver hoister, having a double cylinder 7 by 12, with an extra friction drum added, clutches, and brakes.

The traction was accomplished as follows: One cable, the length of the tramway (1,200 feet), was attached and coiled on one drum of the hoisting engine, and coupled to the end of a train standing on top of bank, loaded and ready to be pulled out on the dam. Another cable (1,200 feet long), attached by one end on the other drum of the hoisting engine, was coupled at the other end to a train unloaded standing out on the dam at the far end of one track. A tail rope, 1,200 feet long, coupled to one end of the train out on dam and passing from it around two horizontal sheaves fixed at the end of the track and back the full length of the tramway, was coupled to the other end of the train standing on bank. When the engine was started the drum, carrying the cable coupled to one end of train standing out on dam, was taking in said cable and hoisting up to bank said unloaded train. The latter being coupled through the tail rope to the other train loaded on bank was pulling it out on dam by the same motion of same drum, the other drum paying out the cable coupled to the other end of loaded train, and *vice versa*.

The track was provided every 20 feet with wooden rollers to overcome the friction of cables on ties. The horizontal sheaves were two, 20 inches in diameter each, fitted in a wooden frame which was secured to brush work of dam with wire cable lashings. The cables and tail rope were one-half inch cast steel cable, having a breaking strain of 7 tons.

The loading of the cars on bank, and the unloading on dam, taking nearly the same time, the delivery of material by the said tail-rope system was about constant. A train was composed of 5 or 6 cars.

When the ballasting had to be done in the middle of the dam only one track was used, extending from one end of the dam to the other. The tail-rope system was not then employed. One cable attached to one drum of the hoisting engine of one side of the dam was pulling the cars out on dam, and another cable attached to a drum of the hoisting engine of the opposite side was hoisting the cars back.

Four thousand six hundred and ninety-three cubic yards of stone were needed in supplement of stone stocked on banks. This extra amount of stone was delivered on barges at the Elmot Bar landing. A wooden rail tramway, with necessary switches, was built across the bar (2,600 feet long), connecting with the track going out on dam. The stone was unloaded from barges and loaded on cars at the landing, pulled by mules on the wooden track to the top of bank near the end of dam; the cables were coupled to train, and the traction then accomplished by the hoisting engines.

The stone once delivered on dam was spread by wheelbarrow, and the paving done by hand.

The thickness of the paving was:

Foot mats	inches.. 4
Slope of dam	do.... 8
Top of dam	feet.. 1
Crown of dam	do.... 1½
Shore mat	inches.. 6

The force employed at each hoisting station was 1 steam engineer, 1 fireman, and 2 helpers.

Eighteen thousand six hundred and ninety-three cubic yards of paving has been done.

Stone employed, 18,693 cubic yards.

Cost of stone	$26,550.78
Coal (2,000 bushels)	200.00
Total cost	26,750.78

Cost per cubic yard, $1.4257.

The total cost of the completed work per cubic unit is as follows:

	Cubic yards.	Cost.
Foot mats	40,988.8	$19,054.86
Cribs	34,581.48	14,909.22
Shore revetment	4,251.84	2,813.20
Grading	3,567	679.86
Paving	18,693	36,862.98
Incidental accounts		18,637.01
Total	102,082.12	92,977.13

The cost per cubic yard of the completed work, including materials, labor, subsistence, and incidental accounts was, therefore, $0.9108.

In incidental accounts are included:

Superintendence	$2,162.58
Construction of quarters	556.40
Construction and maintenance of railroad for stone delivery and hoisting plant	5,866.88
Care of plant	180.24
Care of quarters	422.72
Care of plant	1,801.24
Repairs to plant	398.84
Tools and appliances	395.98
Towing	1,538.65
Transporting of brush	5,493.72

The dam construction was entirely completed January 3, 1894, and all the plant towed down to Memphis January 6, 1894.

At first the progress of construction was slow, owing to the difficulty of getting the labor, on account of the new scale of wages established, but this trouble was ended by calling laborers from Memphis and St. Louis. The work was delayed only two days during the season by bad weather.

During the entire season the work has never been delayed by rise of the river. The water began to rise in the chute only on December 11. The dam was then nearly completed. On December 12 the water existing in the deep pools near both shores rose six-tenths. On the 15th of same month the water had risen 2 feet, and was dammed on the upstream side by the work. The water was seeping through the dam in considerable quantity, and with a strong current. Levels taken on the same day show a water head of 1.78 and 1.64 feet. The bed of the chute was scouring below the apron mats.

The river during the latter part of December was falling, and when the party disbanded on January 4, rising again, but the dam did not show any settlement at that time.

The river keeping on rising reached the 9-foot stage on January 14. The same day considerable settling was reported to have occurred on the Tennessee side, and especially 800 feet from the Tennessee shore. At this location the water was running 3 feet deep and 45 feet wide, the top of the dam having settled to about the level of the bed of chute. Several other depressions had occurred between this break and the

Tennessee shore, and were from 1 to 3 feet deep. On Elmot Bar side a depression of 2½ feet was shown and the current of the water through the dam at this depression was undermining the shore revetment immediately below the dam. The bank of Elmot Bar is composed of very fine sand.

Several surveys were made from January 14 to January 22. These surveys show very small changes in the depression, the break between station 22+8 and station 22+55 on the Tennessee side being, on January 22, 4 feet deep and 47 feet wide, the stage of the river being 3.6 feet.

On January 18 the water above the dam, Tennessee side, was 2 feet 4 inches higher than the water below, the gauge being 8 feet 7 inches. On the 22d gauge being 8 feet 6 inches, the water was 1.75 higher above than below. The differences of water level on the Elmot Bar side were, January 16, gauge 9.25 feet, 2.9 feet higher above; on the 22d, gauge 8.6 feet, 3.27 feet higher above.

Soundings were taken on each side of the dam and no change in the bottom of chute was shown excepting at the large break, where the apron mat was lowered 2 or 3 feet.

The settling occurred at the highest parts of the dam and where bottom of soft material (fine, nearly quicksand) was existing. These places were, as previously stated, covered, before the dam construction, by layer of brush parallel to the current from 0.6 inch to 2 feet 6 inches thick.

The strong current of the water through the dam, due to the head (about 3 feet) must have scoured the soft material under the foot mat and caused the settling.

A spur dike of spalls and small riprap was constructed under the direction of Mr. W. M. Rees, U. S. assistant engineer, by Assistant Engineer Aug. J. Nolty, 75 feet below the dam to arrest the undermining of the shore mat at Elmot side.

Pls. Nos. 6 and 7 showed the settlement of the dam through the center line, and also cross sections of the several depressions. Accompanying this report is a tabulated statement showing expenditures in detail, with quantity of work done and cost per unit. Also 8 plates, showing the location of works, details of construction, details of hoisting plant, and aspect of the dam after settlement had occurred.

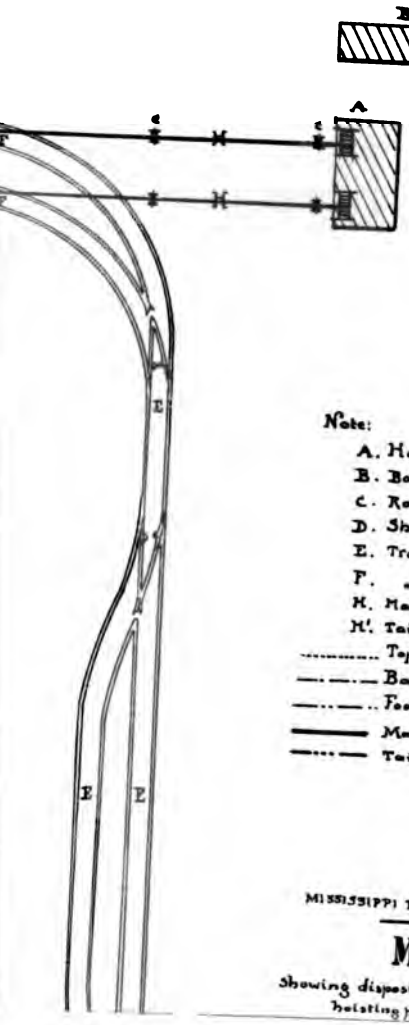
Respectfully submitted.

CHAS. LE VASSEUR,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Abstract of expenditures, Gold Dust Dam construction, fiscal year 1893.

Items.	Incidental accounts.						Dam construction. Earthwork.	
	Superintendence.	Construction and care at quarters.	Railroad and hoisting plant.	Care of and repairs to plant.	Towing.	Transporting brush.	Grading, Tennessee side.	Grading, Elmot Bar side.
Labor	$2,944.08	$425.14	$3,578.96	$1,594.09	.....	$4,560.63	$425.06	$89.40
Subsistence	122.84	73.37	716.17	305.39	.....	933.09	146.98	18.42
Coal	.....	54.12	.....	.....	.....	.....	.....	.....
Lumber	.....	247.40	501.75	59.60	.....	.....	.....	.....
Spikes	.....	13.05	32.20	1.10	.....	.....	.....	.....
Nails	.....	22.50	.40	13.93	.....	.....	.....	.....
Rope	.....	.96	.....	43.20	.....	.....	.....	.....
Steel cable	.....	.....	262.76	.....	.....	.....	.....	.....
Oakum	.....	.....	.....	3.43	.....	.....	.....	.....
Rails	.....	.....	436.55	.....	.....	.....	.....	.....
Joints, rail	.....	.....	84.80	.....	.....	.....	.....	.....
Spikes, rail	.....	.....	56.00	.....	.....	.....	.....	.....
Packing	.....	.....	21.28	.....	.....	.....	.....	.....
Paints	.....	.....	.78	40.98	.....	.....	.....	.....
Marline	.....	.....	.....	.45	.....	.....	.....	.....
Oils	.....	36.25	29.56	61.37	.....	.....	.....	.....
Leather	.....	.....	.37	3.00	.....	.....	.....	.....
Nuts, blank	.....	.....	2.13	.15	.....	.....	.....	.....
Lye and soap	.....	30.22	23.33	.....	.....	.....	.....	.....
Bolts	.....	.....	33.45	.....	.....	.....	.....	.....
Ducking	.....	.12	.....	26.40	.....	.....	.....	.....
Fittings and supplies	.....	.....	32.86	.....	.....	.....	.....	.....
Stationery and stamps	29.66	.....	.....	.....	.....	.....	.....	.....
Miscellaneous materials	.....	75.99	53.53	46.99	.....	.....	.....	.....
Property	.....	.....	.....	395.98	.....	.....	.....	.....
Credit to Ashport Bend	.....	.....	.....	.....	$1,538.65	.....	.....	.....
Freight bills	66.00	.....	.....	.....	.....	.....	.....	.....
Total	3,162.58	979.12	5,866.88	2,596.06	1,538.65	5,493.72	572.04	107.82



Note:

A. Hoisting Machine.
B. Boiler.
C. Rollers.
D. Sheave for tailrope.
E. Track going between Stone piles.
F. " " on dam.
H. Main Cables.
H'. Tailrope.
..... Top of the Dam.
—.—.— Base of the Dam.
—..—.. Foot Mat.
▬▬▬ Main Cables.
—···— Tailrope.

MISSISSIPPI RIVER COMMISSION.

MAP

Showing disposition of tracks and hoisting plant of the

The more recent revetment on Osceola Bar is in good shape. The main channel of river is not near it at present. The older revetment on tow-head has failed at certain points, as follows: (1) A short break in crib dam in Bullerton Chute next head of tow-head on main shore line; (2) a pocket forming in unprotected head of tow-head; (3) an eddy hole and pool about 100 feet in diameter in main bank, 250 feet below head of tow-head; (4) the main channel of river swings into bank about 3,000 feet below head of tow-head. Early in January, 1894, the last 3,000 feet of bank at foot of tow-head was cutting; the bank had sloughed off in many places and about one-third of the stone riprap was gone.

An inspection of the chute behind Bullerton Tow-Head shows that little, if any, sediment passes Sans Souci. Below Sans Souci is a lake-like pool and mud bar too soft to walk on. It is evident that the work of closing the heads of chutes leading behind Bullerton has gone far enough at present; in fact, the fill would be faster if they were more open at the head, the quantity of sediment carried in being proportional to the discharge through chute.

Location and plan of work.—The river mattress was made 250 feet wide, beginning at a point on main shore line 400 feet above head of tow-head in Bullerton Chute, and extending 4,056 feet down front of tow-head. This mattress covered a lot of spur dikes and drift at head of chute and tow-head.

A mattress 90 feet wide, extending 180 feet along head of tow-head, was built in chute just behind crib dam. This was to prevent pool behind crib dam from undermining tow-head.

A section of crib dam about 65 feet long next head of tow-head was rebuilt to a height above the middle portion of dam, for the purpose of maintaining the thalweg of chute channel at a safe distance from head of tow-head. The chute mat lies below and joins the foot of this restored crib.

It was planned to build as little brush work above low-water stage as conditions would permit. River mattresses Nos. 1, 2, and 3 do not extend above 2 feet on the local gauge; river mat No. 4 does not extend above the 5-foot stage, and chute mat (No. 5) is below the 8-foot stage, except the end next to the crib dam.

It was the original intention to let that part of the bank where the slope was no steeper than 1 to 2 stand without grading; but later it was decided to slope everything above a plane of 1 to 3, leaving a bench of not over 6 feet at top of slope, the rock paving to extend from edge of mattress to top of slope and be 10 inches thick.

Labor.—Nearly all the labor employed at Bullerton was subsisted by the Government. The rate of pay with subsistence was 80 cents per day of eight hours for the first month, and 10 cents additional pay per day for each month of continuous service up to the fifth month, with $1.20 per day as the limit. For self-subsisting labor the pay was $1.15 per day for the first month and $1.25 per day for continuous service after the first month.

It was the original intention to employ white labor exclusively, to avoid the troubles usual when white and black labor are subsisted by the same service: but later, after the rush of cotton picking was over, a considerable number of black laborers was employed to the advantage of the work. The best service on the average was given by black labor.

The quantity of labor needed could not be obtained locally or in Memphis; so the force was made up and maintained by ordering white men from St. Louis. The quality of this labor from the cities was bad at first, but was much improved later by a process of selection; many of them only stayed two or three days and others were weeded out. It was found necessary to employ a night watchman to keep them from robbing each other. This watchman was made a deputy sheriff and his authority was not questioned.

On the eve of sinking mattress No. 1, 97 men quit at a time calculated to do the most damage to the work. After this experience, by regulations and management, concerted labor movements aimed at the success of the work were prevented. A base of labor supply as far away as St. Louis was a hardship to the improvement.

The maximum number of laborers employed at any one time was 256 and the total number of employés was 299, including men by the month; 291 of these men were fed and housed by the Government. The total number of laborers employed during the season was 920, 3.6 times the total number employed at any one time.

Materials.—Brush and poles were furnished by contractors and delivered by Government towboats. A considerable portion of the brush and poles used at Bullerton were cut on Osceola Bar and Bullerton Tow-Head by contract and by the Government without any charge for towage.

Three or four inches diameter at the butt for brush and 5 or 6 inches at butt for poles were preferred as maximum limits of sizes desirable for closeness and flexibility of construction, but, because of a scarcity of brush and poles under these limits, sizes an inch or two larger were not rejected. The butt ends of much of the brush delivered from contractors had evidently been chopped off to bring it down to the required size.

Most of the stone used was delivered from storage piles in Ashport Bend by Government towboats. A considerable quantity of stone was graded out of the old

revetment at site of work and used without any charge for towage. A size of stone weighing 10 or 15 pounds was preferred as a limit; but the stone delivered was much larger, many pieces weighing from 30 to 50 pounds.

Four sizes of galvanized steel wire strand were used, the $\frac{5}{16}$, $\frac{3}{8}$, and $\frac{1}{2}$ inch sizes for longitudinal strength in mattress and the $\frac{1}{4}$-inch strand for sewing the fascines to the longitudinal strands. The $\frac{1}{4}$-inch strand was used in selvedge of mattress and in backing up cable fastenings, and the $\frac{3}{8}$-inch strand in channel side of mattress. A piece of $\frac{1}{2}$-inch strand broken in testing strand clamps developed a strength of 64,000 pounds per square inch of net area of section.

Common No. 9 black wire was used in binding the fascines, but was taken off and used over several times. No. 7 galvanized wire and Nos. 7 and 8 silicon-bronze wire were used in fastening poles to mattress.

Two kinds of clamps were used on mattress construction; the Crosby clamps were preferred and used for straight work and held best; the common clamps were used on crossed strand and for friction clamps when slip was desired to distribute strains over several fastenings. The common clamps are cheaper, but the Crosby clamps hold more in proportion to cost as shown by tests. Common fence staples $\frac{5}{16}$ by $1\frac{3}{4}$ inches made of No. 9 black steel wire were used in fastening sewing strands to the fascines.

Towboat service.—The tug *Thomas Heidel* was maintained at Bullerton and did the harbor and fleet work; it also made frequent trips to Ashport Bend in quest of material. The stone and brush were delivered by the Government towboats except the stone graded out of old revetment and the brush and poles cut on Osceola Bar and Bullerton Tow-Head.

The delivery of materials at Bullerton was irregular at times and made a reduction of forces necessary, thereby impairing the efficiency of the forces to a certain extent.

Construction.—The Bullerton revetment party took the field September 21. Up to and including October 4 the force of laborers was small, and, besides the preparations and cutting of brush, only 53 linear feet of mattress was built. October 5, 96 laborers were received from St. Louis and put to work, making a total of 168 laborers. It was October 17 before the forces were up to the maximum requirements.

At the time of beginning work it was not known how far the work of the season would extend. For this reason work was begun at the upstream instead of the downstream end, thereby losing the advantage due to upstream mattresses "shingling" over the heads of the mattresses next below.

November 28, river fascine mat No. 3 was sunk, completing a net total of 3,490 linear feet of mattress made with fascines normal to the bank. Considerable preparation was necessary for river mattress No. 4, which was of special design with fascines parallel to bank and was sunk December 15, completing the river mattress for the season.

During the construction of river mattress Nos. 3 and 4 a surprising quantity of driftwood for the stage was afloat in the river, and it was necessary to keep a gang of men and the tug employed much of the time to keep this drift clear of the mattress. There were the usual delays incidental to this kind of work. Very little time was lost on account of the weather, which was unusually fair for the whole season.

The work to do after December 15 was the building of chute mattress (No. 5) and the completion of the grading and paving. It was expected to finish by the end of December, but delays in the delivery of materials, especially rock, required a reduction of forces in December, and it was January 15 before the work was finished.

River fascine mattress.—For mattresses Nos. 1, 2, and 3 the arrangements of plant and details of construction at Bullerton were similar to those used in Hopefield Bend which are described at length in Assistant Gerig's report.

River fascine mattress No. 4 (250 by 488) was of special construction, and differed from the usual fascine mattress in that the fascines were placed parallel to the bank instead of normal to it. Since this is the only mattress of this style so far built, the method of constructing it is described more in detail below.

Arrangement of plant.—The Bullerton and Hopefield Bend mattress boats were coupled end to end and arranged to make one continuous fascine 588 feet long, but otherwise similar to the fascines used on previous construction.

Mooring of plant (see sketch).—The mooring barges used on mattresses 1, 2, and 3 were placed 800 feet above head of mattress No. 4 and moored normal to bank, as in previous construction. A continuous line of log "dead men," extending the whole length of mooring barges (260 feet), was placed on deck and chained to the "timberheads" held by the shore cables. These "dead men" were to hold the parallel cables mooring the mattress and mattress plant. This set of barges was called the upper mooring barges, and the distance of 800 feet enabled mattress to sink in deep water without being dragged upstream. The lower mooring barges, 3 in number, and 360 feet long over all, were moored normal to bank in the usual way. They were not moored to upper mooring barges, because it was desired to adjust them independently for position, and have additional security in case the load of drift became too great on upper mooring barges. They carried but little load, except from slip

lines, at time of sinking mat, and acted as a spar to hold mattress and mattress plant in positon. They also served as material tenders and as moorings for extra barges. The seven steel-wire cables from upper mooring barges to mattress passed under and the two 2-inch manila lines used in mooring mattress plant passed over these lower mooring barges. A log waling placed on top downstream timberheads kept the upper lines free to swing over these barges. A line from head of mattress boat to outer end of these barges was used in swinging mat boats when mattress was launched. A set of blocks midway and another set at lower end of mat boats aided the launching of the mattress.

Wire strand.—Two systems of wire strand were used in mattress No. 4 (see Sheet No. 1).

The usual $\frac{5}{16}$-inch wire strands, wound upon reels on mattress boats, were paid out in parallel lines 8 and 9 feet apart normal to fascine and the bank, and the fascines were sewed and clamped to them with $\frac{1}{2}$-inch wire strand and Crosby clamps, as in previous construction. There were sixty-six of the $\frac{5}{16}$-inch strands and four $\frac{1}{2}$-inch strands—two at head of mattress, one 150 feet from head, and one at foot of mattress.

For longitudinal strength there was, in addition to the strength of the fascines, that of twelve $\frac{1}{2}$-inch and two $\frac{5}{8}$-inch wire strands the whole length of the mat (500 feet). These longitudinal strands were built into mattress in the following manner: When the mattress was built to the desired point the longitudinal strand was stretched over the normal strands and mattress "ways," and each intersection with the normal strand was clamped with a common clamp. The upstream end of strand was given two turns around mattress head and carried back and clamped to itself at 130 feet, thereby forming a loop around mattress head. For additional security a pair of $\frac{5}{16}$-inch backing-up strands clamping to $\frac{1}{2}$-inch strand at 100-foot point were carried to the adjacent strands at 150 feet, where they clamped to a double-sewing strand, taking in the $\frac{1}{2}$-inch normal strand put there for that purpose.

Mattress head (see Sheets Nos. 1 and 4).—The mattress head of No. 4 differed from previous construction in that it was a kind of jointed spar, designed to adjust to the bed of the river when sunk. This spar was made up of 14 cypress logs about 12 inches in diameter, and varying in length from 28 feet next shore to 14 feet on outstream end, all put in place before launching from mattress boats. The logs were placed about 3 feet from head of mattress with laps of 2 feet. A $\frac{3}{4}$-inch drift bolt 2 feet long was driven horizontally through both logs at each lap, and, in addition the logs, were bound together by several turns of wire strand at each pin point. The logs were secured to mattress by two lines of $\frac{1}{2}$-inch sewing strand, and to every alternate log two of the longitudinal wire strands of mattress were made fast. Spanning these same alternate logs 2-inch manila rope mattress-mooring loops were made fast at the same points receiving the longitudinal strands. Each one of these rope loops formed an equilateral triangle, with its log for base and with the shackles of its mattress mooring cable at the vertex.

Poles on mattress.—Parallel lines of poles 16 feet apart were wired to mattress normal to fascines and the bank for stiffness. It was feared that without them the mat would be so flexible as to fold up in sinking. These poles were wired to the mattress every 5 feet and each alternate wire was silicon bronze. Parallel lines of poles 16 feet apart were also placed longitudinally to keep the rock from rolling off the mattress. On the outstream edge of mattress the poles were cribbed two high, as additional security against rock rolling off.

Mooring of mattress.—Mattress No. 4 was moored by seven $1\frac{3}{8}$ and $1\frac{1}{4}$ inch steel wire cables anchored to the "dead men" on decks of upper mooring barges 800 feet above mattress, thence passing under lower mooring barges and connecting to the seven 2-inch manila rope mattress loops by shackles with pin lines to trip after sinking mattress. Owing to the curved shore line these mooring cables had a lead which held the out corner of mattress against any current tending to buckle the flexible mattress head. Besides the usual "slip lines" used in sinking mattress, a line was led from out corner of mattress to a point farther out on mooring barges like a "breast line" to prevent folding in sinking.

Sinking of mattress.—Since the method differs somewhat from other practice it will be described more in detail.

The sinking was done without the aid of towboats. The tug delivered the rock barges and towed them back after mattress was sunk, but did not venture over mattress during sinking because of risk to the propeller. The mattress was first ballasted nearly to the sinking point with rock delivered direct from barges by wheelbarrows on run-plank the usual way. The head of the mattress held up by the "slip lines" was ballasted to its full load and then lowered enough to let the rock barges in end on. Two rock barges were lashed end to end and swung from the mooring barges by three parallel 2-inch manila lines long enough to pay out over whole length of mattress.

With every man to his place and signals understood, after the first 50 feet of mattress was heavily ballasted the signal was given for the slip-line men to lower away, and

hey lowered away slowly and continuously until the mattress head was on the bottom f the river and all the slip lines slack; an operation consuming less than one minute f time. Particular care was taken to have the mattress head sink to bottom without delay, so that the friction of mattress on bottom would aid the mooring cables in olding mattress and to avoid the heavier strain which would result from a submerged mattress waving in the current free from the bottom; a strain which may ause the loss of a mattress.

The two coupled rock barges were dropped down over mattress by the three lines nd the rock thrown over evenly and continuously. The desired distance from bank vas maintained by skewing the barges to the current. The whole operation of inking lasted fifteen or twenty minutes. The mattress went down evenly and vithout mishap.

No. 4 was the last river mattress built, and the force of laborers was not up to the naximum. It was not deemed expedient to increase the forces for the few days necessary to build this one mattress. The fascines were more than double the usual length, and because of the small labor force the cost of building this mattress was nore per square than on mattresses Nos. 1, 2, and 3. It is thought that with a labor force between the limits of one man per 1¼ feet length of fascine and one man per foot the labor cost of building this style of fascine mattress will not be materially greater than that of the older style of this season. The quantity of brush and poles is the same, but the item of wire strand is increased.

The sizes of the river fascine mattresses built are as follows:

	Squares.
River mat No. 1 (250 by 1,243 feet)	3,108
River mat No. 2 (250 by 1,044 feet)	2,610
River mat No. 3 (250 by 1,203 feet)	3,007
River mat No. 4 (250 by 588 feet)	1,470
Gross total (4,078 feet)	10,195
Net total (4,018 feet)	10,037

The average lap of mattresses on shore edge is 20 feet, but this lap is more on channel edge because of curve in shore line.

Connecting mattresses.—Only 211 squares of connecting mattresses were built. These were in two small pockets at head of tow-head and were made like the old-style woven mattress.

Chute mattress.—Only one mattress 90 feet wide by 180 feet long (162 squares) was built at head of tow-head and behind crib dam. It was made in place on the surface of the ground and water with fascines 180 feet long. Twenty $\frac{5}{16}$-inch wire strands 200 feet long were first stretched parallel and 9 feet apart across site of mattress and beyond. After the start was made the brush was laid upon 4 by 8 inch skids 8 feet long placed on top of mattress already built; the sewing strand was then passed under both the $\frac{5}{16}$-inch strand and this brush and drawn tight with block tackle, by this means drawing the brush into its position in mat and shaping it into a fascine. After all the fascines were in place, each one of the twenty $\frac{5}{16}$-inch strands was given a turn around the last fascine and returned on top of mattress to its origin and the two ends clamped together, thereby inclosing the whole mattress in closed loops. The top return strand was clamped to the sewing strand every fifth fascine.

It was found that the men could work on that part of the mattress floating on the water without wetting their feet. The brush had been cut about a month and had more buoyancy than green brush.

Crib dam.—This dam is only 5 feet high by 65 feet long, built after the old style, with hopper-shaped holes for ballast, and with side slopes of 1 to 3. It continues the old crib dam to tow-head. The remains of a spur dike projecting from tow-head at end of dam were graded away as an obstruction liable to cause local erosion in head of tow-head.

Grading.—A considerable part of the total area graded was done by hand, being on site of old revetment with rock in the way and the cut too thin to grade to advantage with hydraulic grader. The hand grading was very expensive compared to hydraulic grading under favorable conditions.

Pile-driver boat No. 21 was rigged for hydraulic grading and most of the material was moved by this means. The pump furnished one stream through a 1-inch "ring nozzle" at a pressure of about 150 pounds per square inch.

Big grader No. 4 was used five days with two hose streams. Work done by this grader was found to cost more than with No. 21, so No. 4 was laid up at the end of the week.

Part of the bank was graded below the plane of the old revetment and the presence of brush and stone and wire made the grading much slower. However, the value of the rock recovered was more than the extra cost of grading.

Three-inch rubber hose "sewed" with marline was used in grading. This hose measured 2¾ inches in diameter inside the hose, and 2¾ inches inside the hose couplings. The friction of 100 feet of this hose, as determined by test, was found to be

9 pounds, with a velocity of 13 feet per second through the hose, 149 pounds per square inch at nozzle, and discharging 241 gallons per minute under about the average conditions of everyday service. The nozzle used in determining above results was a 1-inch "ring nozzle," which developed a coefficient of discharge greater than that of a properly constructed ring nozzle, and was the same nozzle used in grading.

All bank steeper than a slope of 1 to 3 was graded off, and a bench about 6 feet high was left at top of slope.

Paving.—The graded slope was paved with a layer of stone 10 inches thick, shading to 8 inches thick at top of slope. More stone was used at edge of mattress because of less connecting mattress, the layer at edge of mattress being always as much as 12 inches thick and sometimes as much as 18 inches.

When spalls were available a layer 3 or 4 inches thick was first laid down and the larger stone laid over it in a compact and regular manner. This layer of spalls placed next the ground is expected to prevent the pavement from washing and gullying. Such stones as were too large for even pavement were broken with sledges in place and the spalls used in the chinks.

Besides the 17,808 cubic yards of stone delivered by the Government towboat, 728 cubic yards graded out of old revetment was used in this paving. The slope in head of tow-head bordering on chute mat, as well as the flat shore in head of chute, was paved uniformly with the rest.

Map of work.—The accompanying outline map shows the location of the work.

Statement.—Appended is an abstract of expenditures showing the distribution of materials and cost of the Bullerton work.

The average net cost of the river fascine mattress is $5.96 per square of 100 square feet. This average net cost was somewhat increased by the extra cost of river mattress No. 4, for reasons already given.

The average net cost per square of "bank revetment" is $8.50. The chute and connecting mattresses and the crib dam were so small that average costs are not given.

The total average net cost per linear foot of "revetment" is $21.98, which includes all material and labor expended on the Bullerton work.

The total cost of 4,018 net linear feet of revetment is $88,307.18.

Respectfully submitted.

E. L. COOLEY,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Abstract of expenditures, improving Mississippi River at Bullerton Tow-Head, Arkansas, during season 1893–'94.

Items.	Superintendence.	Care of plant.	Repairs to plant.	Towboats.	River mattress, (10,195 squares).		Chute mattress. Connecting mattress. Crib dam.	
					Quantity.	Cost.	Quantity.	Cost
Labor	$1,702.63	$1,209.88	$464.96	$979.75	.....	$8,285.65	.....	$736.50
Subsistence service	30.21	49.70	24.61	31.81	.....	816.16	.....	129.72
Subsistence stores	95.96	157.81	73.77	101.03	.....	2,705.76	.....	344.75
Brush.....cords	.....	.....	.....	.....	12,846	14,122.54	550	461.75
Poles.....do	.....	.....	.....	.....	448	668.27	30.3	34.24
Piling.....linear feet	.....	.....	.....	.....	1,492	63.41	.....	.....
Stone.....cubic yards	.....	.....	.....	.....	9,184	15,980.47	479.3	834.91
Wire:								
Black.....pounds	.....	.....	.....	.....	551	10.96	.....	.....
Galvanized.....do	.....	.....	.....	.....	14,300	342.05	.....	.....
Copper.....do	.....	.....	.....	.....	10,908	1,871.38	438	75.14
Strand.....do	.....	.....	.....	.....	97,870	3,469.86	1,981	70.25
Staples.....do	.....	.....	.....	.....	2,547	182.97	171	12.31
Clamps.....number	.....	.....	.....	.....	12,041	1,185.47	402	39.58
Spikes and nails..pounds	.....	.....	34.32	.....	109	2.97	.....	.....
Iron and steel.....do	.....	.....	26.86	.....	.....	4.63	.....	.....
Cables (wire rope)	.....	.....	.....	.....	.....	630.62	.....	.....
Manila rope	.....	.....	.....	.....	.....	1,200.80	.....	.....
Lumber	.....	.....	84.96	.....	.....	.....	.....	.....
Oils and engineers' supplies	.....	105.72	.....	24.82	.....	.60	.....	.....
Coal	.....	39.54	.....	130.00	.....	.....	.....	.....
Tug hire	.....	.....	.....	742.00	.....	.....	.....	.....
Towage	.....	.....	.....	4,683.79	.....	.....	.....	.....
Miscellaneous	.....	143.28	59.46	6.41	.....	408.08	.....	.....
Total	1,828.80	1,705.93	768.94	6,699.61	.....	51,952.65	.....	2,740.57

Abstract of expenditures, improving Mississippi River at Bullerton Tow-Head, Arkansas' during season 1893–'94—Continued.

Items.	Bank revetment.						Total (4,018 linear feet of revetment).		Quantities per square of river mattress of 10,195 squares
	Clearing bank.	Hydraulic grading.	Hand grading.	Paving bank (2,871 squares). Quantity.	Paving bank (2,871 squares). Cost.	Miscellaneous.	Quantity.	Cost.	
Labor	$202.38	$917.03	$517.18		$3,696.61	$293.86		$19,006.43	
Subsistence service	54.61	31.81	51.05		226.90	60.42		1,506.60	
Subsistence stores	173.44	101.03	162.14		832.63	176.29		4,924.64	
Brush ..... cords							13,405	14,587.30	1.26
Poles ..... do							478.3	702.51	.044
Piling ..... linear feet							1,492	63.41	.146
Stone ..... cubic yards				8,873	14,900.57		18,536.3	31,715.05	.901
Wire:									
Black ..... pounds							551	10.96	.054
Galvanized ..... do							14,300	342.05	1.403
Copper ..... do							11,346	1,946.52	1.07
Strand ..... do							99,851	3,540.09	9.6
Staples ..... do							2,718	195.28	.25
Clamps ..... number							12,443	1,225.05	.985
Spikes and nails ..... pounds							1,361	37.29	
Iron and steel ..... do								31.49	
Cables (wire rope)								630.62	
Manila rope								1,209.80	
Lumber								84.96	
Oils and engineers' supplies		25.44						156.58	
Coal		172.32						341.86	
Tug hire								742.09	
Towage								4,683.79	
Miscellaneous		14.67						631.99	
Total	430.43	1,262.30	730.37		19,656.71	530.57		88,307.18	

Items.	River mattress.	Chute mattress.	Bank revetment.	Total.
Clearing bank			$430.43	
Hydraulic grading			1,262.30	
Hand grading			730.37	
Paving bank			19,656.71	
Superintendence	$51,952.65	$2,740.87	22,079.81	$76,773.33
Care of plant	1,237.55	65.29	525.96	1,828.80
Repairs to plant	1,154.41	60.90	490.62	1,705.93
Miscellaneous	520.34	27.45	221.15	768.94
Towboats	359.04	18.94	152.59	530.57
	5,524.77	248.73	926.11	6,699.61
Total	60,748.76	3,162.18	24,396.24	88,307.18
Net cost per square of mattress and revetment, and per linear foot of revetment	5.96		8.50	21.93

RECEIPTS AND EXPENDITURES.

Received:	
Pay roll	$22,159.89
Commissary stores	5,235.88
Material and property	16,772.75
Material from Assistant Nolty	41,220.07
Material from Assistant Gerig	1,658.05
Material from Assistant Le Vasseur	242.06
Third District	274.85
Bill for tug hire	742.00
Towing	4,683.79
Total	92,990.24
Expended:	
As per statement	88,307.18
Transferred to Assistant Nolty	1,351.81
Transferred to Assistant Rees	3,082.14
Transferred to property	285.11
Total	92,990.24

APPENDIX 2 E.

REPORT OF ASSISTANT ENGINEER WILLIAM GERIG ON IMPROVING MISSISSIPPI RIVER AT HOPEFIELD BEND, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., March 10, 1894.

CAPTAIN: I have the honor to submit my report on improving Mississippi River at Hopefield Bend, Arkansas, during the fall of 1893.

The work covered by the project embraced repairs to breaks in the revetment made during the flood of 1893, and a general strengthening of the remaining work where it was necessary.

Description.—The lower portion of the revetment, 2 miles long, was built during the seasons of 1884, 1887, and 1888. The first break in this work occurred during the flood of 1890, and was repaired by a complete revetment, 762 feet long, built in the fall of 1890. The flood of 1891 caused breaks above this repair work to the extent of 3,350 feet, which were repaired during the season of 1891-'92. The flood of 1892 caused breaks above and below these repairs, which were repaired during the season of 1892-'93. An examination made in August, 1893, showed that the flood of 1893 caused almost a continuous break in the revetment from section 58 to 78, beginning at the foot of the revetment of 1890 and extending about 150 feet over the head of river mat No. 1, constructed during the season of 1892-'93, and also the receding of the bank line at Hopefield Point, proper, from section 90 to 100; from section 90 to 95 being a remnant of the work of 1888, the bank line having moved back fully 75 feet behind the former revetted slope.

The old mats in both these breaks have settled over their whole width, least at the river edge and greatest at the shore edge. The shore work from section 58 to 78 was almost entirely destroyed, with the exception of a few points. From section 77 to 80 a large hole was washed out behind the paving, being deepest at section 77, where the elevation of the bottom of the hole was about 3 feet below the zero of the Memphis gauge, and paving entirely gone for 50 feet; from thence the elevation of the bottom of the hole became higher until it reached the top of the paving at section 80, leaving a projection about 250 feet long, and being about 100 feet from shore line at section 77+50. At section 90 to 95 the shore work was entirely destroyed.

The repairs of the present season consisted in restoring the first-mentioned block of the old 1888 work by fascine mats 300 feet wide and a new shore paving, and in restoring in like manner the lower block of revetment of the same year's work and extending the revetment about 500 feet downstream to protect Hopefield Point, proper, where caving has recently set in, and repairing old work in such places where it was deemed necessary. The river being very low, the water's edge of the paving near the zero contour was repaired from the head of the old work down over the entire revetted bank.

The construction of the original revetment was as follows: River mats of the fascine type, 310 feet wide, generally sunk with their inner edge along the zero contour, but in some places the inner edge is about at the 3-foot contour, making the width below the zero line about 300 feet. Where necessary, connecting mats of the fascine type were placed and extended up to the water line, so as to get a good foundation for the paving, an extra amount of stone being placed along the zero contour.

The weak points in the old revetment as observed are—

(1) That the mats have settled and the breaks have been caused by scour of the current through the brush work, or by the conveyance of the material from under the mat by the return flow of water from the saturated bank when the river commenced to fall, and, consequently, that the form of woven mats here used do not have the requisite degree of compactness or impermeability to resist destruction from either of the two above-named causes.

(2) The insufficient width of the old mats, as they did not reach the deep water and may be undermined.

(3) Insufficient ballast on the bank work, exposing the underlying brush to the air and moisture, causing rapid decay. After three or four years much of the exposed brush work is thoroughly rotten.

Plan.—To make the repairs above described the plan was, (1) to make the river and connecting mats of the fascine type at least 300 feet wide; (2) to not extend the brush work above the water line; (3) upon a graded bank, with a slope not steeper than 1 on 3, to place 3 to 4 inches of crushed stone and 5 to 7 inches of small riprap closely packed.

Construction.—Work began immediately after the arrival of the plant from New Madrid, Mo., on September 1, 1893, and was finished December 1, 1893. The season was the best in many years, and the river remained practically at the 3-foot stage

during the entire season. The first time lost by rain was on September 8, and total time lost by rain four days.

Labor.—The supply was at all times sufficient. Whites, subsisted by the Government, were employed in all the responsible positions. Most of the common laborers were negroes, and self-subsisting. They were good laborers, steady and submissive, and the pick of this class of labor, since no public work was being done in this vicinity and the factories, oil and saw mills were all closed. The price paid was $25 per month and subsistence. The self-subsisting laborer received $1.15 per day of eight hours for the first month of full time, and $1.25 per day thereafter, if full time was made. Only a few white laborers were subsisted on the fleet, principally sailormen. The maximum force employed was 469, on October 23, 1893.

Materials.—Brush and poles were obtained by contract at $1.02 per cord for the former and $1.50 per cord for the latter, and the source of supply was from 20 to 45 miles below the work. The deliveries were prompt, since only about two days were lost on account of brush. The average rate of delivery during the month of October was about 500 cords per working day. Better progress could have been made under the favorable conditions existing, had the supply been about 700 cords per day.

Stone was obtained by contract from Imboden and Black Rock, Ark., and delivered by rail—about 8,500 tons on barges and the remainder on the bank. In the beginning some trouble was experienced in getting the deliveries on the barges promptly and getting the cars promptly unloaded on the banks. The stone was of the same quality as used at Hopefield Bend during the season of 1892–'93. The riprap was in pieces weighing from 5 to 35 pounds, and the crushed stone of dimensions to go through a 2-inch ring.

Fascine mats.—The method of holding mooring barges and the mat by means of cables fastened on the bank was the same as in previous years.

A set of platform or fascine barges were used in addition and made to join the mat ways, being parallel to each other longitudinally. The platform barges were ordinary barges with an elevated deck raised to the same elevation as the platform on the mattress ways, and along the side of these barges, near the mat ways, formers were constructed to make the fascines in, the top of the formers being at the same elevation as the highest point on the mat ways. Brush of diameters at the butt of 1 to 4 inches was placed in these formers and compressed into round bundles or fascines 12 inches in diameter by means of lever chains, and while the pressure was on the chains the brush was tied together with No. 12 galvanized steel wire. The length of the fascine was the same as the width of the mat, in this case 310 feet, and were at right angles to the bank. Under the platform of the ways barges 39 reels were placed, 8 feet apart. The first two reels on the outside or channel edge of the barges contained $\frac{3}{8}$-inch galvanized steel wire strand composed of 7 wires whose estimated breaking strength is 4,640 pounds each, and the remaining 37 reels contained $\frac{5}{16}$-inch galvanized steel wire strand composed of 7 wires, the estimated breaking strength of each strand being 3,360 pounds. These are the bottom cables. The ends of these cables were made fast to the head and are under the mat at right angles to the fascines. Each cable was in one piece, its length being determined by the length of the mat. Friction brakes were used on the reels to keep the bottom cables taut.

The method of procedure during the construction of a fascine mat was, first, a large head of hard-wood poles was made, the diameter of the butts of the poles being from 4 to 8 inches, and to this head were fastened the bottom cables. The weaving strands, which were $\frac{1}{4}$-inch galvanized steel wire strands composed of 7 wires, with an estimated breaking strength of 1,600 pounds, were also fastened to the head at the same places as the bottom strands, and hence there were 39 of these, 8 feet apart. Then a fascine was made, care being taken to keep the butts of the brush scattered; the fascine was next raised out of the formers and pushed to the ways and down to the head. Now the weaving cable was passed over the fascine, then down under the fascine and bottom strand, and then up between the fascine and head; and then a pair of 6-inch blocks, one end fastened to the mooring barges, and the other, by means of a "Haven clamp," was attached to the weaving strand, and 6 men pulled the fascine down to the head. While the strain was on the weaving strand it was either clamped to the bottom strand or held so the fascines could not separate from the head or from one another, by driving a staple into the butt of a willow so as to take both the weaving and bottom strands. The staples were made of No. 9 wire and were $1\frac{1}{2}$ inches long, with an opening in the clear of $\frac{5}{8}$ inch so as to grip the strands. The weaving and bottom strands were clamped together every tenth fascine, besides being stapled so that the fascines could not slip apart.

The labor was divided into three distinct parties. One party unloaded the brush off the barges, the second party carried the brush to the formers and made the fascines, and the third party assisted the second in raising the fascines out of the for-

mers down on the ways and tied them together. When the ways were filled the friction brakes were raised and the launch made, the brakes being put on again before the launch was completed, so as to get a uniform strain on each strand. When the mat was completed, longitudinal poles were placed over it, the rows being 8 feet apart, and were fastened to the mat with No. 12 galvanized steel wire and No. 9 copper or silicon-bronze wire. These wires encircled a fascine and the pole. Care was taken to keep the galvanized wires and the copper or bronze wires well apart, so that no chemical action would take place and destroy the wires.

On the outside or channel edge and on top of the mat was a ½-inch galvanized steel wire strand composed of 19 wires, the breaking strength being 20,000 pounds. This cable was fastened to the head of the mat at the same places as the other strands; however, before reaching the head one turn was taken around the second head, which was about 10 feet from the mat head and was made of hard-wood poles, then fastened to the head. This wire extended over the whole length of the mat and was clamped to the weaving cable at every 10 feet, the clamps being put on so as to come half way between the clamps on the bottom strand. One end of the shackle strap was fastened to the second head at the same point where this cable was fastened. Sixteen feet from this cable toward the shore was another ½-inch cable fastened in like manner, but extending over only one-half the length of the mat, and the other end of the shackle strap was fastened to the second head at the point where this cable encircled it. Then 24 feet from this, another ½-inch cable extending over the whole length of the mat, and one end of shackle strap No. 2 was fastened the same way. Sixteen feet from this was another ⅝-inch cable extending over one-half the length of the mat, the other end of shackle strap No. 2 being fastened to the second head at the same point where this cable encircled it; and also ⅝-inch cables were placed the same as above at the locations of shackle straps Nos. 3, 4, and 5. The shackle straps were fastened to mat by first taking a turn around the main head and then to the second head, around which two turns were taken. Seven shackle lines were used, 40 feet apart. The combined breaking strength of the wire strands on the mat was 126 tons (of 2,240 pounds).

At first the progress of construction was slow, owing to the fact that the labor was green. Better progress could have been made with a more abundant supply of brush. The following table, which explains itself, shows that with three barges of brush on hand and well loaded an average of at least 150 linear feet per day could have been made. The supply at this place was generally two barges per day, or about 500 cords per day. When the supply is three barges the distance of carrying the brush to the formers is reduced and, as most of the delay is in getting the brush off the barges, a larger force could have been employed here and the delay reduced to a minimum.

Mats 310 feet wide.

Mats.	Length of mat.	Maximum made one day.	Average length of mat made per day.	Number of men on day maximum number feet made.	Average number of men per day.	Number of barges brush worked from on day maximum mat made.	Average number of barges brush per day on work.
		Feet.	*Feet.*				
No. 1	650	140	93	271	220	2	2
No. 2	800	135	127	293	280	3	2⅔
No. 3	700	175	140	342	300	3	2⅔
No. 4	916	173	153	313	320	4	2½

On mat No. 4, when the maximum length per day was made, the number of men was less than the average, this being due to using brush from four barges and the brush was well loaded. The above is the number of men actually employed on the mat, and the sailor men.

Mattress construction was begun on September 7 and completed on October 26, 1893, when the last mat was sunk. Four mattresses were sunk, of the following dimensions:

Mat No. 1	feet	650 by 310
Mat No. 2	do	800 by 310
Mat No. 3	do	700 by 310
Mat No. 4	do	916 by 310
Total mat made	linear feet	3,066
Total bank protected	do	2,930
Total squares (100 square feet) made		9,287.6
Total squares of bank covered		9,085

The cost in detail was:

Labor and subsistence	$13,384.31
15,222.7 cords of brush	15,527.15
490 cords of poles	735.00
5,800 tons (gross) stone	9,802.00
44,344 pounds of No. 12 wire (steel)	993.00
800 pounds of No. 9 wire (steel)	18.80
5,075 pounds of No. 9 wire (copper and bronze)	811.62
101,837 pounds of wire strand	3,746.69
15,567 clamps	953.18
1,660 pounds staples	96.80
Manila rope	1,218.49
Piling	10.80
Wire rope (mooring cables, one-half value)	1,315.86
Miscellaneous material	44.15
Superintendence	1,029.08
Care of plant	759.80
Repairs to plant	1,425.13
Towing	2,967.41
Miscellaneous expenses	321.75
Total	55,161.02

Cost per square built, $5.940.

Cost per square of bank covered, $6.072.

Average quantities of material used in the construction of one square (100 square feet) of fascine mat:

Brush	cords	1.639
Poles	do	.053
Stone	tons	.625
Wire, steel	pounds	4.861
Wire, copper	do	.546
Wire strand	do	10.965
Clamps	number	1 500

Grading.—The bank was graded to a slope of 1 on 3, or flatter. This slope was not carried to the top of the banks, a shoulder 4 to 6 feet high being left. Hydraulic grading began September 15, after the mat No. 1 was sunk, and the last grader finished November 8, 1893. The graders used were No. 40 and pile-driver No. 20, the same as employed last season. Prior to grading the bank was cleared of timber, drift, and old mat work, and after grading with the pumps the grade was neatly dressed by hand and stumps removed by blasting. The cost in detail is as follows:

Labor and subsistence	$1,066.92
Coal	258.91
Oils, and engineers' supplies	4.11
Repairs to graders	228.00
Total	1,557.94

Work done, 1,975 linear feet = 28,940 cubic yards; cost, $0.054 per cubic yard.

The excessive cost was due to the bad condition of the graders.

Cost in detail of total work done preparatory to paving 3,400 linear feet of bank:

Clearing bank	$570.03
Hand grading	684.81
Hydraulic grading	1,557.94
Towing	54.00
Total	2,866.78

Cost per linear foot, 84 cents.

Connecting mats.—Narrow connecting mats were placed where the river mats did not come up to the water's edge, and in pockets. These were of the fascine type, fascines being parallel to the bank. They lap the river mat from 10 to 30 feet. From section 75 to 78 + 20 a connecting mat was placed behind the projecting point.

This was of the old form of mat. Also under the Memphis and Little Rock Railway's incline the brush was "hurdled" around the piling and was made extra thick; from the piling out the connecting mat was of the fascine type. At section 91 a small connecting fascine mat, 150 by 150 feet, was sunk, connecting the work of last season with mat No. 4. These mats varied in width from 20 to 150 feet. Two thousand one hundred and seventy-five linear feet were built, the average width of all the connecting mats being 56.10 feet.

Total linear feet made and sunk	2,175
Total squares made and sunk	1,221.2

Total cost in detail of the connecting mats was:

Labor and subsistence	$2,438.24
2,875.7 cords of brush	2,933.22
149 cords of poles	236.00
800 tons of stone	1,352.00
7,877 pounds wire, steel	156.76
257 pounds wire, copper	43.69
2,710 pounds wire, strand	117.34
311 pounds staples	35.46
Manila rope	33.00
Miscellaneous material	37.80
Superintendence	168.39
Care of plant	124.33
Repairs to plant	233.10
Towing	570.40
Miscellaneous expenses	52.60
Total	8,532.43

Cost per square, $6.987.

The average quantities of material used in the construction of one square was:

Brush	cords	2.355
Poles	do	.122
Stone	tons	.660

The increase of brush was due to extra quantity placed in the hole at station 75 and around the piling at the incline.

Paving.—This work began on September 27, 1893, and was completed on November 30, 1893. Paving began at or near the low-water stage and extended from the 26 to the 30-foot contour, on an average to the 28.5-foot contour. The paving was carried to this height to get above the strata of sand. The stone used in paving was from 5 to 35 pounds in weight, the average thickness of the paving being about 10 inches—3½ inches of crushed rock and 6½ inches of riprap. The linear feet of bank paved was 3,066. The square feet of bank paved was 311,200 = 34,567 square yards.

The cost in detail was:

Labor and subsistence	$4,253.25
11,125.45 tons of stone	18,985.64
Miscellaneous material	30.15
Clearing and grading	2,866.78
Superintendence	580.03
Care of plant	428.25
Repairs to plant	803.26
Towing	523.00
Miscellaneous expenses	181.35
Total	28,651.71

Cost per square foot, $0.092 and $0.83 per square yard.

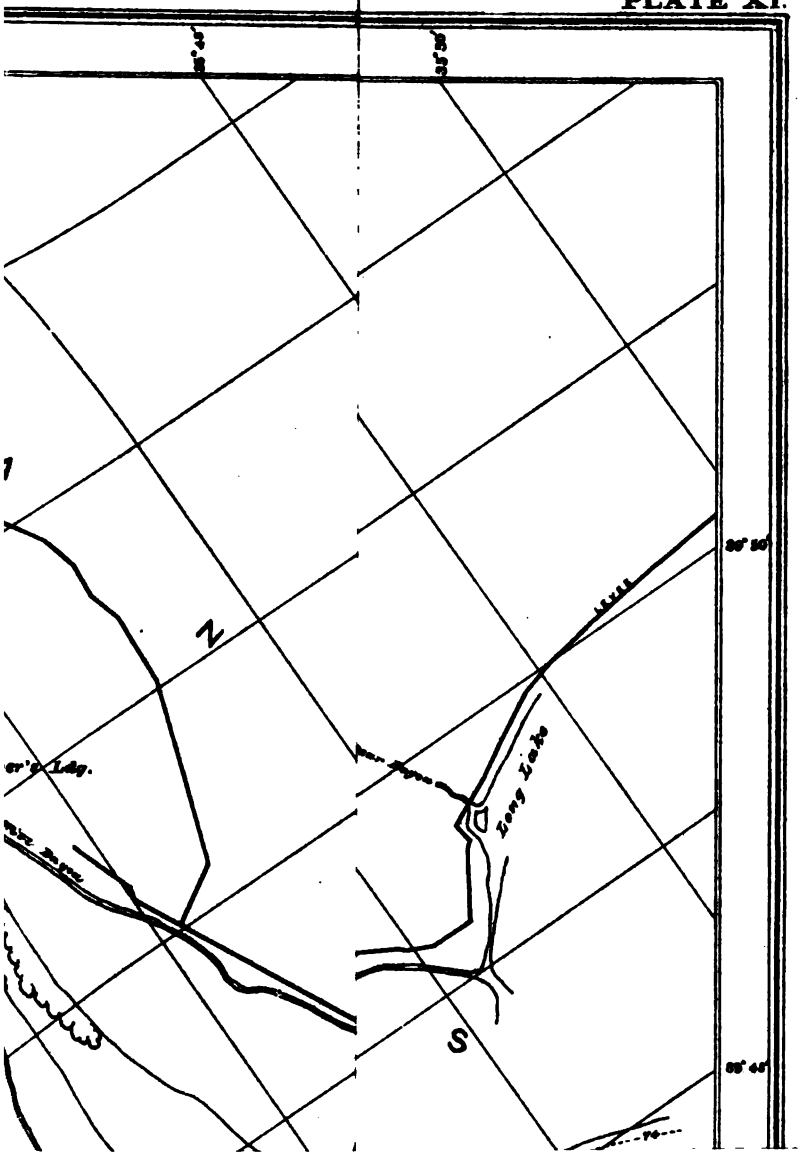
Repaving old work.—This consisted in repairing the places along the water's edge which were exposed by the extreme low water and also the repaving of portions of the bank where the underlying mat was decayed. About 500 feet of this bank were repaved from near the zero contour to the 26-foot contour and about 5,000 feet along the water's edge. The total work covered was 62,200 square feet.

The cost in detail was:

Labor and subsistence	$850.61
1,855 tons of stone	3,177.10
Miscellaneous material	6.05
Superintendence	93.55
Care of plant	69.08
Repairs to plant	129.55
Towing	114.00
Miscellaneous expenses	29.30
Total	4,469.27

Cost per square foot, $0.072.

PLATE XI.



Abstract of expenditures at Hopefield Bend, Arkansas, during 1893 and 1894—Cont'd.

	Bank revetment.					Repairing old work (quantity and cost).		Tow-boats.	Miscellaneous.	Total.
	Clearing.	Hand grading.	Hydraulic grading.	Paving bank (quantity and cost).						
Labor	$548.35	$664.84	$828.99		$4,122.24		$824.45	$1,891.66	$451.59	$28,331.50
Subsistence service	5.85	5.39	64.22		35.37		7.07	185.33	36.01	761.50
Subsistence stores	15.83	14.58	173.71		95.64		19.12	375.69	97.40	1,934.11
Brush ..... cords										18,460.37
Poles ..... do										971.00
Stone ..... tons				11,125.45	18,985.64	1,855	3,177.10			33,316.74
Wire, No. 12, steel, pounds										1,149.76
Wire, No. 9 ... lbs										18.80
Wire, No. 7, copper, pounds										855.31
Wire strand steel, pounds										3,864.00
Coal ..... boxes			258.91					1,242.00		1,711.66
Clips .... number										953.10
Staples ... pounds										132.26
Manila rope .. do										1,251.49
Lumber, feet, B. M.										553.51
Spikes and nails, pounds										89.35
Piling, linear feet										10.80
Iron and steel, lbs										244.85
Oakum ..... do										27.44
Paints										49.92
Oils and engineers' supplies			4.11					36.23		113.01
Cable (wire rope)										1,315.98
Salt										12.75
Tug hire								470.00		470.00
Miscellaneous					30.15		6.05	27.90		416.42
Total	570.03	684.81	1,329.94		23,269.04		4,033.79	4,228.81	585.00	96,814.43

Total bank protected, complete	linear feet	3,066
Cost per linear foot		$30.12
4 river mats	squares	9,287.6
Cost per square		$6.054
Brush per square	cords	1.679
Stone per square	tons	0.625
Connecting mats	squares	1,221.2
Cost per square		$6.987
Brush per square	cords	2.355
Stone per square	tons	0.660
Paving bank	square feet	311,200
Cost per square foot		$0.09
Repairing old work	square feet	62,200
Cost per square foot		$0.072

Dr.		Cr.	
Total material received	$72,139.65	Expended as per abstract	$96,814.43
Labor	28,932.08	Expended for property	578.00
Miscellaneous	215.37	Material, etc., transferred to Plum Point plant	3,894.67
Total	101,287.10	Total	101,287.10

APPENDIX 2 F.

REPORT OF ASSISTANT ENGINEER WILLIAM M. REES ON REPAIRS TO PLANT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 17, 1894.

CAPTAIN: I have the honor to submit the following report on repairs to plant from March 31, 1893, to May 1, 1894:

This work was continued at Amelia, Ark., until October, 1893, under the immediate charge of Assistant Aug. J. Nolty, after which only minor repairs were made by parties in the field. Upon the close of the season's work, January 26, 1894, all plant was removed to Memphis, Tenn., and I assumed direct charge of repairs, etc.

Steamer Minnetonka.—In September, 1893, engines and boilers were overhauled, wheel repaired, and new bitts placed preparatory to putting boat in commission for brush towage. An examination showed that the boat would need extensive repairs, and in April, 1894, work was begun, the repairs comprising entire new decks and deck beams, outriggers, guards, fantails and pitmen, new stacks, extensive repairs to breeching, furnace and fire bed, wheel and rudder, and a thorough overhauling of machinery and pipes, including boring out of cylinders. Cabin is to be repaired and the boat painted. Much of this work has been finished and the balance is now in progress.

Steamer Titan.—Only minor repairs were made. The wire-rope hogchains giving evidence of stretching were replaced by iron rods.

Steamer H. M. Graham.—In the summer of 1893, this boat received extensive repairs to hull and machinery, comprising new stem and two new sternposts, 40 feet of new bottom aft and 40 feet forward, 80 new futtocks, 35 half floors, 3 half-deck beams, 4 deck beams in forecastle, 3 hogchain fastenings, side planking renewed for 35 feet from stem, knuckles and grub strake, capstan foundation, nosing, clamp strakes and breasthooks, in forecastle, and deck on bow and in fire, engine, and deck room, all renewed; new stem bank was put on and bow sheathed with iron and hull painted. Boilers received two new sheets and new breeching and stacks were erected. Furnace was rebuilt, machinery overhauled, and wheel and roof repaired. Further repairs were made during the past month. The boiler deck was repaired outside of cabin and covered with canvas, and the boat painted throughout. The machinery was also overhauled, and new side pipes to starboard engine put in and bow calked. This boat is old, but will probably be serviceable for two seasons.

Surrey Steamer H. L. Abbot.—This boat was docked and thoroughly repaired in February and March of the current year. The repairs comprised 69 new top timbers and nearly as many futtocks; nearly all new sides, including knuckle strakes, half the bilge keelsons, half the side strakes, new ends to brace fastening, new cylinder timbers, pitman and wheel, new outriggers, guards and decking outside, rudder rebuilt, engine cylinders bored out, new tubes put in heaters and location of latter changed, pipes, pumps, and machinery overhauled, and pipes covered and boat painted and calked. Present condition medium.

Iron stern-wheel tug Itasca.—A contract was entered into with Messrs. Dan. Shea & Co., to replace side and bottom plating which was worn out, and the boat sent to Memphis for this purpose. She also received new armor plating for the head, also new iron wheel complete and new pitmen; engines were bored out, machinery, pipes, and boiler were overhauled, a new roof put on and boat painted throughout. These repairs were completed March 13, 1894. Present condition of the boat good.

Machine-shop boat No. 1.—Repaired last March. Received entire new guards, with new top gunwale pieces at ends, new timber heads, hatches and coamings, new deck outside, and was calked and seams payed off. Present condition medium.

Hydraulic graders Nos. 2 and 4.—Calked afloat; decks repaired; new timber heads put in where required; pumps and other machinery overhauled; bursted water cylinder on No. 2 replaced by a new and better designed one; large hoisting engines sent to experimental dredge and replaced by smaller ones taken from condemned pile-drivers. Both graders are old, having been built in 1881; the decks are bad and No. 2 needs new shoring under the large pumps which are letting down. Should last two more seasons.

Office boat Mississippi.—Hull rebuilt; new gunwales placed inside the old ones, thus narrowing the beam 10 inches; new deck beams, timber heads, kevils, and hatches; new deck outside of cabin; boat calked all around and cabin ceiled and sided inside with half-inch matched lumber, and hull and cabin painted. Present condition good.

Office boat No. 39.—All but the top gunwale strakes removed and replaced by new ones; deck repaired; hull caulked; range pipes and flues repaired; roof renewed and cabin painted inside. Present condition good.

Quarter boat No. 11.—Received minor repairs during the summer of 1893 and is now undergoing repairs by placing a coal barge hull under the cabin. When these repairs are completed its condition will be good.

Quarter boat No. 8.—Used as commissary store boat. Was docked, calked, had rakes and gunwales patched, and decayed stringers and floor beams renewed. Condition bad. Will last another season.

Quarter boat No. 26.—Used as material store boat. Repaired by replacing old hull with the hull of a fairly good coal barge. New guards and deck outside. Present condition good.

Quarter boat No. 27.—Calked all around while afloat; guards repaired; new outside stanchions put in and stoves and pipes repaired. Present condition fair.

Quarter boat No. 25.—Received minor repairs. Sides calked near the water line and stoves, pipes, and flues repaired. Condition bad. Hull will last another season.

Quarter boat No. 13.—Docked and found to be in bad condition. Sides were

sheathed from bottom to 1 foot above water line with 3-inch plank and calked. Condition bad. With care may last another season.

Quarter boat No. 6.—Gunwales repaired and calked while afloat. New timber heads put in and some minor repairs done. Condition medium. Should last two seasons.

Quarter boat No. 12.—Received only minor repairs and calking near the water line while afloat. Guards now nearly in condition to fall off. With repairs may last another season.

Quarter boat No. 30.—Received only minor repairs. No longer serviceable nor worthy of repairs.

Pile-drivers Nos. 19, 20, and 21.—These, the best of the pile-drivers, were fitted up for work during the summer of 1893 by making general repairs while afloat. A pump from an old driver was put in No. 19. All had additional feet water heaters coupled to the ones already aboard. Leads, decks, and timber heads were repaired. As the leads on all are practically worn out, the sides and rakes badly decayed, it was decided to rebuild them from the bottom gunwale up, together with new decks and leads. Nos. 19 and 21 have been docked and have received new sides. They are still under repair, and No. 20 will be similarly treated. When repairs are completed these drivers will be in good condition.

Pile-drivers Nos. 26 and 57.—These received slight repairs and were used, the former as a quarter boat and the latter as a pumping boat, in recovering coal from a sunken barge. Machinery was removed from both. Condition bad and not worthy of repairs.

Pile-driver No. 27.—Hull no longer seaworthy. Machinery has been removed. Not worthy of repair.

Pile-drivers Nos. 25, 38, 56, 58, and 59, and sand-pump boat No. 12.—These were stripped of machinery, condemned as not worthy of repairs, and sold at public auction.

Mooring barges Nos. 3 and 4.—New stem pieces were put in these; rakes renewed; gunwales repaired; new timber heads put in; 5 tie-rods placed on each barge, and bottom, sides, and rakes calked. Present condition fair.

Mat barges Nos. 5 and 6.—These were constructed from coal barges and received extensive repairs. New gunwales from bottom strake up were put in; new stem pieces, rake timbers and rake plank; new fenders and timber heads; decks, platform and ways were repaired, and bottom, sides, and rakes calked. Later, both had upper works and decks removed and hulls placed under cabins of quarter boats Nos. 11 and 26.

Barges Nos. 202, 206, 211, 215, 224, 227, and 65.—These were docked and thoroughly repaired.

Barges Nos. 55, 74, 94, 134, 204, 210, 212, 213, and fuel barge D.—These were repaired without docking. Barges numbered from 134 down are district barges, 100 feet long by 25 feet wide, and are in medium fair condition. Those numbered from 200 up are framed barges, 120 feet long by 30 feet wide. They were built in 1889 and now require extensive repairs in order to make them serviceable for handling heavy cargoes. Fuel barge D is worn out.

Barge No. 933.—This is a new one built in 1893. An accident broke a number of bottom plank, and the barge was docked and repaired.

Flats.—Three were built of the following dimensions: Length, 50 feet; width, 15 feet, and depth of hold, 3 feet. They have 5-inch long leaf-pine gunwales, one 3-inch cypress longitudinal bulkhead, 2½-inch cypress bottom, and 2-inch cypress decks.

Skiffs.—All that were worthy of it were repaired, receiving new bottoms and calking.

Fascine mat plant.—Three complete plants were fitted up. The regular mat barges were used. These were fitted up with the requisite drums, brakes, and guide sheaves for carrying the longitudinal bottom strands used in the construction of fascine mats. For constructing the fascines, old barges unfit for carrying heavy loads were fitted up with the necessary platforms, ways, formers, and chokers.

Gold Dust Dam work.—Two pile-driver hoisting engines were altered for cable haulage of materials, each set of engines receiving an extra drum with necessary brakes and clutches.

Eight new four-wheel cars were made; also rollers, sheaves, switches, frogs, and other necessary appliances.

Miscellaneous work.—A large amount of work was done for the various field parties. Three hundred run plank were beveled at ends and riveted to prevent splitting, and 22,203 cable clamps were made. These had both bolts threaded instead of only one as heretofore.

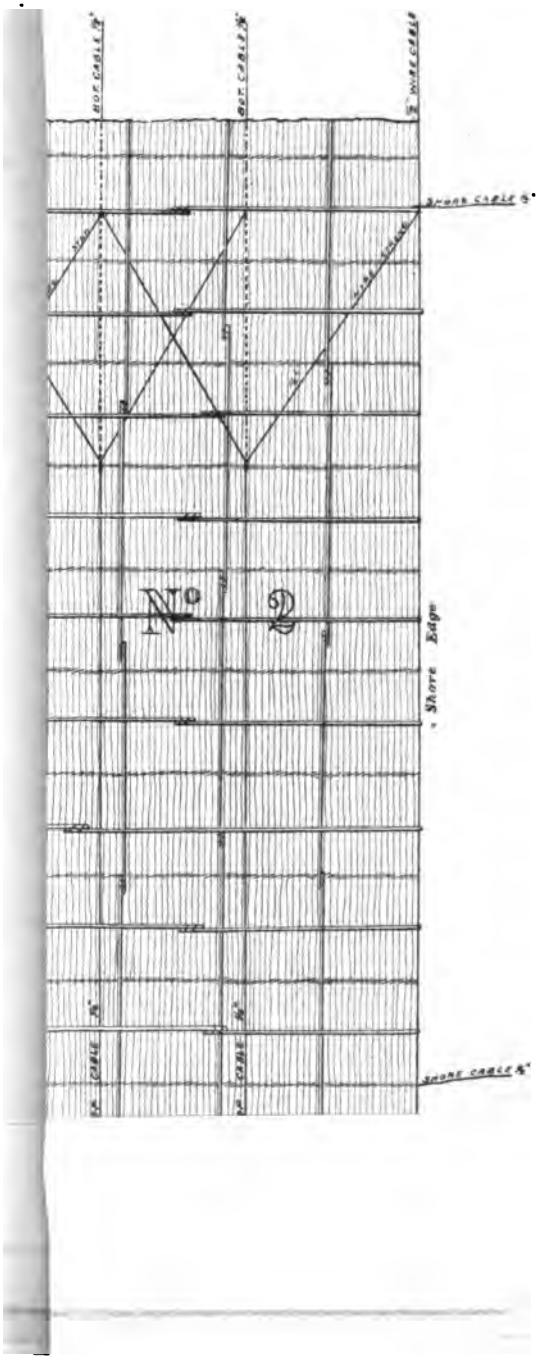
A statement of the cost of repairs in detail is transmitted herewith.

Respectfully submitted.

WM. M. REES,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

PLATE XIII.



Abstract of proposals for levee work in vicinity of Bear Bayou, Arkansas, received in response to advertisement dated September 5, 1893, and opened September 15, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From station 3395 to station 3340, about 90,000 cubic yards (per cubic yard).	From station 3340 to station 3300, about 89,000 cubic yards (per cubic yard).
		Cents.	*Cents.*
1	Timothy Sullivan, Memphis, Tenn	21¼	*16
2	Hartnett & O'Brien, Memphis, Tenn	23	2
3	Robert Johnsen, Memphis, Tenn	*18.49	19
4	P. F. Lamb, Memphis, Tenn	19.45	2
5	James M. Sullivan, Memphis, Tenn	26½	2
6	J. S. McTighe & Co	26	2

* Accepted.

Abstract of proposals for levee work in Lower White River levee district, received in response to advertisement dated November 10, 1893, and opened November 18, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From station 556+30 southward (about 39,500 cubic yards) per cubic yard
		Cents.
1	Timothy Sullivan, Memphis, Tenn	1
2	Jennings & Co., Memphis, Tenn	*12
3	J. B. Lewis, Memphis, Tenn	13
4	A. Arnold & Co., Memphis, Tenn	15

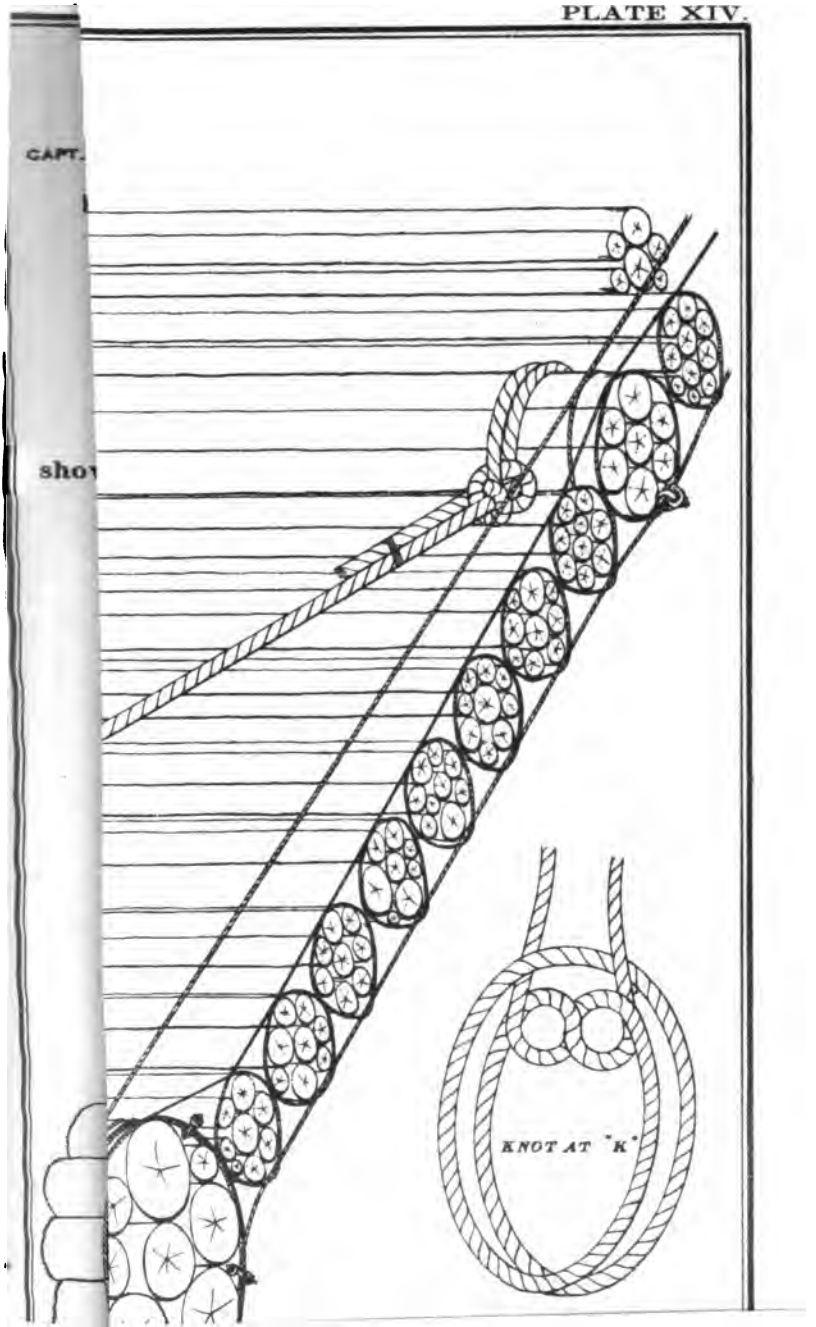
* Accepted.

Abstract of proposals for levee work in Upper Yazoo levee district, received in response to advertisement dated January 16, 1894, and opened January 31, 1894, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Sections 20 to 24 (160,000 cubic yards), per cubic yard.	Sections 25 to 29 (143,000 cubic yards), per cubic yard.	Sections 30 to 33 (153,000 cubic yards), per cubic yard.	Sections 34 to 37 (157,000 cubic yards), per cubic yard.	Sections 38 to 41 (152,000 cubic yards) per cubic yard
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents*
1	W. A. Shippey, Friars Point, Miss		11.99	14.90	18½	14.99
2	Forrest & Co., Memphis, Tenn	16	18	20	27	27
3	J. B. Lewis & Co., Memphis, Tenn	13.98	12.98	16½	21½	17½
4	Thomas Hinchey Rice, Helena, Ark	11½	12.24	16.25	23	15
5	John Scott & Son, St. Louis, Mo	11.87	13.45	15½	22	16
6	Homan & McFadden, Baton Rouge, La	15.55	15½	17.7	24	21
7	Timothy Sullivan, Memphis, Tenn	14½	14½	31	34	35
8	Starling-Smith Company, Greenville, Miss				18½	
9	C. A. Winter, Greenville, Miss	12	11½	13		15.70
10	Jeffries & Dameron, Memphis, Tenn	15½	16½	16½	21½	17½
11	Robert Vance, Memphis, Tenn	14	15.80	16	20	15.24
12	J. C. Hodge, Natchez, Miss	12½	14	13½	22	17½
13	Manning & Gibson, Natchez, Miss	12	12	13½		
14	James H. Carey, Memphis, Tenn	14	15	19	23	15
15	Robert Johnsen, Memphis, Tenn	11½	14½	15½	19.74	17.74
16	Terrel & Watkins, Beulah, Miss	12.34	13	12.48	21	15
17	T. S. Aderholdt, Friars Point, Miss	13	13½	14	24	19½
18	W. S. Withers & Co., Memphis, Tenn	12.44	13.74	12½	24	17.48
19	John G. Seessions, Hampton, Miss	11½	*11½	13.93	21.93	15.93
20	Hugh Morgan, Memphis, Tenn	11½				
21	J. S. McTighe & Co., Memphis, Tenn	13.39	12.70	15.39	18.39	17.40
22	McLaughlin Bros., Memphis, Tenn	11.94	12.75	*12½	19	*15½
23	Arnold & DeGaris, Memphis, Tenn	14	13½	17	*16.98	16½

*Accepted.

NOTE.—Bids for work on Sections 20 to 24 rejected on account of want of sufficient funds.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Abstract of proposals for levee work in Upper White River levee district, received in response to advertisement dated April 19, 1894, and opened April 30, 1894, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From Station 1298 southward as far as funds ($17,000) will permit, per cubic yard.
		Cents
1	T. H. Rice, Helena, Ark.	12⅝
2	John A. Cannon, Greenville, Miss.	16¾
3	Timothy Sullivan, Memphis, Tenn.	11.74
4	J. C. Hodge, Memphis, Tenn.	13½
5	Bobbitt & Leeper, Baton Rouge, La.	13⅜
6	Jeffries & Dameron, Memphis, Tenn.	13¾
7	Forrest & Co., Memphis, Tenn.	*10.45
8	Ben. Talley, Memphis, Tenn.	13.2[illegible]
9	Garbish & O'Neil, Memphis, Tenn.	11.4[illegible]
10	J. S. McTighe & Co., Memphis, Tenn.	14.49
11	Arnold & DeGaris, Memphis, Tenn.	13
12	Robert Johnsen, Memphis, Tenn.	12.49
13	Batt O'Brien, Memphis, Tenn.	12.[illegible]
14	T. S. Aderholdt, Friars Point, Miss.	12.74

* Accepted.

Abstract of proposals for furnishing riprap stone and quarry spalls, received in response to advertisement dated May 12, 1894, and opened May 24, 1894, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Unloaded by the contractor.				Unloaded by the Government.			
		Limestone.		Sandstone.		Limestone.		Sandstone.	
		Riprap, per cubic yard.	Spalls, per cubic yard.	Riprap, per cubic yard.	Spalls, per cubic yard.	Riprap, per cubic yard.	Spalls, per cubic yard.	Riprap, per cubic yard.	Spalls, per cubic yard.
1	Sterling, Fort & Co., Searcy, Ark.*	$1.579	$1.579	$1.579	$1.579	$1.379	$1.379	$1.379	$1.379
2	Edward Hely, West Plains, Mo	1.79	1.49	1.79	1.49	1.59	1.29	1.59	1.29
3	Fred. Hartweg, Cincinnati, Ohio	1.84	1.47	1.79	1.42	1.66	1.28	1.64	1.25
4	John Barrett, Cincinnati, Ohio	1.78	1.63	.....	.....	1.63	1.48	.....	.....
5	J. S. McTighe & Co., Memphis, Tenn.†	1.67	1.45	.....	.....	1.47	1.25	.....	.....

* Bid withdrawn.

† Accepted.

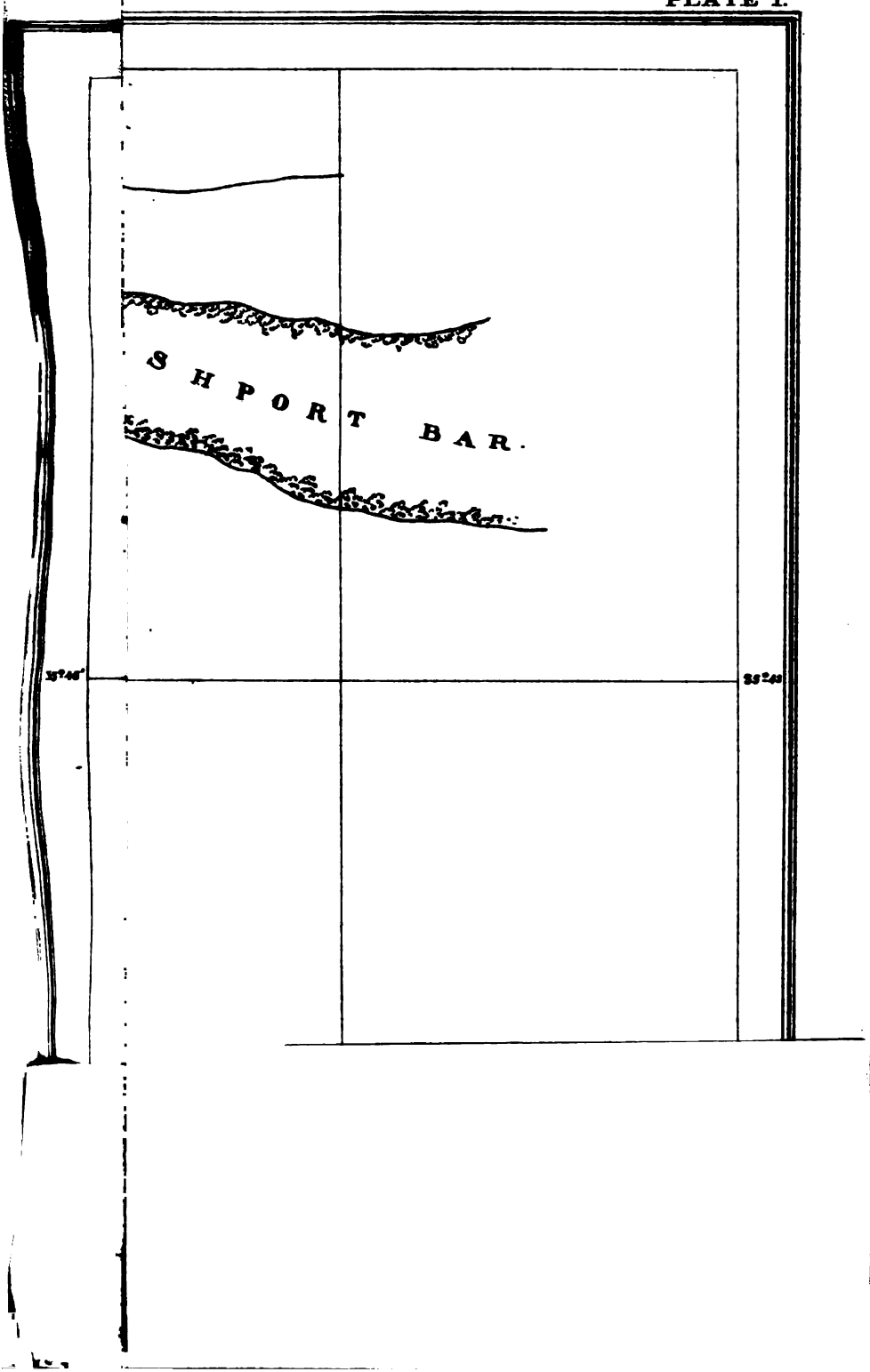
List of civilian engineers employed on works of improving Mississippi River, first and second districts, in charge of Capt. S. W. Roessler, Corps of Engineers, from June 1, 1893, to May 31, 1894.

Names and residence.	Time employed.	Pay per month.	Where employed.	Work on which employed.
	Mos.			
W. M. Rees, Memphis, Tenn ...	11	$200	Memphis and in the field.	Office and miscellaneous field work.
	1	250		
Aug. J. Nolty, Memphis, Tenn .	2	150	Amelia, Ark., and Ashport, Tenn.	Construction, Plum Point Reach.
	10	175		
C. W. Sturtevant, Appleton City, Mo.	12	150	Amelia, Ark., and Memphis, Tenn.	Repairs to plant and construction of experimental dredge.
William Gerig, Columbia, Mo ..	4	125	Various points	Surveys and construction work.
	8	150		
Fred. Wigstrand, Memphis, Tenn.	8 9/30	125	Pushmataha, Miss ..	Construction and repairs of levees.
A. L. Dabney, Vicksburg, Miss .	10 3/30	125	Laconia, Ark	Do.
A. F. Kilpatrick, Memphis, Tenn.	12	125	Friars Point, Miss., and Rosa, Ark.	Do.
M. Gardner, Memphis, Tenn ...	12	125	Allison's, Ark., and Austin, Miss.	Do.
E. T. Washburne, Clarksdale, Miss.	2 2/30	150	Featherstone, Ark..	Do.
C. H. Purvis, Helena, Ark.....	3/30	125	Modoc, Ark.....	Do.
	1 7/30	150		
B. B. Gordon, Greenville, Miss .	10 7/30	150	Amelia, Ark., and Memphis, Tenn.	Surveys, gauges, and observations.
E. L. Cooley, Chicago, Ill	7 17/30	150	Bullerton, Ark	Construction, Plum Point Reach.
Chas. Le Vasseur, Memphis, Tenn.	4 5/30	125	Gold Dust, Tenn....	Do.
Wm. Shelton, Memphis, Tenn..	1	90	Memphis, Tenn.....	Office work.

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, First and Second districts.

Class of property.	No.	Approximate value May 31, 1894.	Class of property.	No.	Approximate value May 31, 1894.
Steamer Minnetonka.....	1	$19,000.00	Experimental dredge.....	1	$60,000.00
Steamer Titan.....	1	12,000.00	Machine-shop boats.....	2	7,000.00
Steamer Itasca.....	1	8,000.00	Floating dock.....	1	3,000.00
Steamer H. M. Graham.....	1	4,000.00	Flatboats	6	1,500.00
Steamer H. L. Abbot.....	1	3,500.00	Skiffs, etc.....	36	300.00
Pile-drivers	7	4,500.00	Storehouse.....	1	1,800.00
Quarter boats.....	12	11,000.00	Tools, appliances, and outfit.....	....	12,000.00
Barges.....	70	104,000.00	Office furniture.....	....	500.00
Mooring	4	6,000.00	Surveying instruments.....	....	1,500.00
Mattress	6	16,000.00			
Hydraulic graders.....	3	15,000.00	Total.....	....	290,600.00

PLATE I.



FINANCIAL STATEMENT.

Improving Mississippi River, first and second districts.

June 1, 1893, balance unexpended	$253,787.16	
May 31, 1894, amounts allotted by Mississippi River Commission since last statement	958,000.00	
May 31, 1894, proceeds of Government property	205.15	
May 31, 1894, amounts refunded on account of over-payments and errors	3.27	
		$1,211,995.58
May 31, 1894, amount expended from June 1, 1893, to date	1,080,459.94	
May 31, 1894, amounts deposited to credit of Treasurer United States, being proceeds of Government property	205.15	
		1,080,665.09
June 1, 1894, balance unexpended		131,330.49
June 1, 1894, outstanding liabilities	32,900.00	
June 1, 1894, amount covered by incompleted contracts	11,653.27	
		44,553.27
Balance available		86,777.22

Examinations, surveys, and contingencies of rivers and harbors.

Oct. 19, 1893, to amount allotted by Chief of Engineers U. S. Army	$218.00
Nov. 14, 1893, by amount expended	218.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	$1,000,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

APPENDIX 3.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 31, 1894.

GENERAL: I have the honor to submit the following report of operations in the third district, improving Mississippi River, for the year ending May 31, 1894:

This district extends from the mouth of White River to Warrenton, Miss., a distance of 220 miles. In its improvement work has been undertaken at Lake Bolivar front, Ashbrook Neck, Greenville, Lake Providence Reach, Delta Point, and Vicksburg, and levees have been constructed and enlarged in the Lower Yazoo, Upper Tensas, and Middle Tensas levee districts.

The operations of the last season have consisted in the maintenance and repair of existing bank revetment and the construction and enlargement of levees.

Lake Bolivar front (417 miles below Cairo).—The object of this improvement has been to stop a caving of the bank which was threatening the destruction of a large levee across the end of Lake Bolivar.

In 1888-'89, 4,250 feet of bank were protected by a revetment of brush and stone, as described in the Report of the Chief of Engineers for 1889, p. 2704. The width of subaqueous mat for the upper portion of the work was 250 feet; the lower 1,100 feet were covered by a mat with a width of but 180 feet. The bank above low water was graded to a slope of 1 on 3 and covered with a brush revetment loaded with 2.39 cubic yards of stone per running foot.

The brush in the upper bank revetment endured for about three years, but it has recently been rapidly decaying and has been replaced by a layer of 10 inches of stone wherever there is a tendency for the river to destroy it. Two hundred and thirty cubic yards of stone were expended for this purpose during the last fiscal year.

The revetment has accomplished the purpose for which it has been constructed. The caving has ceased at the end of the lake, though still active just below the work.

Soundings taken at this locality in December, 1892, showed that there had been a deposit from the river over the mats 250 feet wide, but a scour along the 180-foot mat, which had caused it to settle from 5 to 15 feet at its outer edge. To prevent this tendency to undermine, 685 linear feet of subaqueous mat were constructed during the last fiscal year and sunk at the lower end of the work. The width given to the mats was 300 feet. The form of mat construction heretofore used was modified by reenforcing the 100 feet next the bank with an additional layer of brush, making the mat nearly 2 feet in thickness at its inner edge and 1 foot at its outer.

The quantity of material per square of 100 feet was:

Brush	cords..	.96
Poles	do....	.15
Stone	cubic yards..	.53
Wire	pounds..	5.50
Cable	do....	4.29

The cost of repairs was $17,565.66. A detailed description of the work will be found in the appended report of Assistant Engineer Arthur Hider upon repairs to revetment.

A survey of July, 1893, showed that during the preceding high water there was a deposit along this entire front, but during low water the current was observed to again impinge upon the lower end of the revetment.

Ashbrook Neck (446 miles below Cairo).—Ashbrook Neck is the upper of four "necks" or "points" of land inclosed in the tortuous course of the Mississippi River in the vicinity of Greenville. The object of the improvement at this locality is to prevent the river from cutting through this neck and leaving its present channel, with a disturbance of the regimen of the river both above and below it.

The work of revetting this neck was begun during the season 1890–'91 and completed in 1892–'93; 8,900 feet of bank were covered with a revetment consisting of a subaqueous mat of a width varying from 250 to 300 feet. The upper bank was graded to slopes from 1 on 3 to 1 on 5 and covered with 10 inches of stone to a two-thirds stage. During the last season the repair work has consisted in placing 972 cubic yards of stone on the upper bank revetment, at Station 105, where a sloughing was observed, due to an underlying layer of quicksand, and from Stations 90 to 114, where insufficient stone had been placed upon the revetment during its construction. The cost of repairs has been $2,192.96.

Soundings taken in July, 1893, show an average scour of 9 feet at the outer edge of the mats. The mats appear to have adjusted themselves to their new bed without injury. Caving has continued above and below the work, and, although the damage to the revetment has been slight this last season, it will be necessary to extend the work about 2,000 feet farther up the river at an early date to prevent its gradual destruction by being flanked by the caving above.

Greenville Harbor (478 miles below Cairo).—The object of the improvement at Greenville has been to prevent the caving of the bank at this locality, which was rapidly destroying the city. In 1887, 1888, and 1889 the front of the town was protected by a system of spur dikes, which are fully described in the reports of the Chief of Engineers for those years. The caving has ceased in front of the town, but has continued in the bend above it.

During the flood of 1890 this caving flanked the upper dikes and threatened the destruction of the remainder. In 1891 the work of revetting the bend above the town was commenced and continued during the season of 1892–'93, 11,050 feet of revetment being constructed during the two years, similar to that at Ashbrook Neck, except that the subaqueous mat had a uniform width of 300 feet.

During the last season minor repairs have been made to the revetment and bank above the two-thirds stage; 1,526 cubic yards of stone were expended for this purpose, at a cost of $2,519. The river has continued the scouring action noted in my last annual report, causing settlement of the revetment, particularly at the outer edge of the mats. The revetment appears to have adjusted itself to the changed slope without injury, except in the vicinity of the upper of the city dikes. During the high water of 1894 this dike was undermined and carried away. This left the lower end of the revetment exposed to attack.

An examination of the revetment at the close of February, 1894, showed a damage to the upper bank revetment at the dike and in the pocket between it and the dike below.

Soundings indicated a settlement of the subaqueous mat for a distance of 400 feet above the dike. Soundings in May, 1894, indicated that this settlement had extended to Station 57, 900 feet above the dike, and a break in the upper bank revetment at Station 61 was also observed. Caving has also been active in the unrevetted portion of the reach above the town. The revetment should be extended to a point of no caving at both the upper and lower ends of the reach. The dikes are

rigid to adjust themselves to the deepening of the river channel, which has ompanied the revetment of this bend.

ake Providence Reach.—This reach extends from Carolina Landing, 517 miles below ro, to Island 95, a distance of 35 miles. A description of the earlier operations his reach will be found in my annual report for 1892.

1 1889 work was begun under the existing project, which consists in revetting uisiana Bend (520 miles below Cairo) to check the extensive caving which has n taking place at this locality, and to give greater permanency in direction to river currents throughout the reach. Work was continued during the seasons 1–'92 and 1892–'93, the total length of bank protected to date being 16,859 feet.

he revetment is of similar construction to that at Greenville, with the exception cross the mouth of Old River where, the material in the bank being a soft mud, upper revetment of stone was placed on mats of brush to distribute the weight.

fter the flood of 1893 an examination of the work showed considerable scour ind the revetment across the mouth of Old River. Along the lower 4,600 feet a ilar settlement of the outer edge of the mat was observed as at Greenville and ıbrook Neck.

letween stations 128 and 136 the riprap on the upper bank had settled in places l bulged up at others, due to a lack of stability in the material on which the stone s placed.

n allotment of $10,000 having been made for the repairs of this work, five dikes rush and stone were constructed behind the revetment at the mouth of Old River, l the two built last season extended for the purpose of preventing the scour which s undermining the revetment. At the localities where the riprap had settled, the ne was stripped from the surface, and the slope regraded and repaved. A ditch s dug to drain a pond which was considered a possible cause of the sloughing served, and stone was added to the slope above the last mat constructed last son, which had not been properly riprapped, due to the high stage of water at ich the work was done. The cost of the repairs was $7,578.31. A detailed descrip- n of the work is given in the appended report of Assistant Engineer Arthur Hider.

'o complete the protection of this bend it will be necessary to continue the revet- nt down the river about 5,000 feet. The lower end of the work is being destroyed the caving below. During the past season about 50 feet of the upper bank revet- nt has been damaged from this cause.

Vicksburg Harbor and Delta Point (599 miles below Cairo).—The holding of Delta int has been an essential feature of all projects for the improvement of Vicksburg rbor. From 1878 to 1884, 10,700 feet of revetment was constructed at this locality, ich has required very little repairs until this season. The holding of the bank s been accompanied by the same increase in channel depths noted at Ashbrook ck, Greenville, and Louisiana Bend, at the upper end of the work the outer edge the mat having settled 50 feet and assumed a slope below water of nearly 1 on 1.

'o prevent the continuance of this undermining action, 1,000 feet of subaqueous 'etment was constructed. The width of mats was 300 feet. They were of similar nstruction to those used at Lake Bolivar front, except that, due to the strength of e current at this locality, an extra number of cables was used.

The upper bank revetment, which consisted of a revetment of brush weighted wn with stone, was replaced by a revetment of stone 10 inches thick wherever it as exposed to scour from the river, the grading of the bank being done by hand, e old slopes of 1 on 2½ being retained. The cost of this work was $26.32 per linear ot of completed work.

The amount of material expended was as follows:

		Per square of 100 feet.	Per running foot.
ush	cords..	.913	3.03
les	do....	.17	.56
one	cubic yards..	*.74 †2.8	4.07
ire	pounds..	9.42	30.41
ible	do....	7.56	23.86

* Mat. † Upper bank.

A detailed account of the work will be found in the appended report of Assistant ngineer Arthur Hider.

The project for the improvement of Vicksburg Harbor, recommended by the Mis- ssippi River Commission and approved by the Secretary of War in 1887, consisted dredging a basin in front of the city, to be connected with the river at Kleinstone y a canal. This basin and canal was to be inclosed on its north and west sides by

an earthen dam, to be constructed from the material dredged, so as to limit the ... of water in them during floods and thus reduce the amount of deposit.

Work on this project has been continued from year to year as funds were ... able. The amounts of material dredged are as follows, measured in scows:

	Cubic yards.
1888	...
1890	46,...
1891	331,...
1892	290,...
1893	31,...
Total	1,72...

The river and harbor act approved July 13, 1892, contained the following provis... "Improving mouth of Yazoo River (Mississippi) in accordance with the plan of Cap... J. H. Willard, Corps of Engineers, U. S. Army, dated February 4, 1892, contai... in House Ex. Doc. No. 125, Fifty-second Congress, first session, * * * $75,0... This plan contemplates closing the existing mouth of the Yazoo River and diverti... the river through Centennial Lake by the city, and is incompatible with the pla... of the Mississippi River Commission for improving the harbor of Vicksburg, nec... sitating the removal of the dam at the head of the basin.

As it was evident from former experience that a large annual deposit was to ... expected from the Mississippi River unless some means were taken to check it... inflow, I recommended in my last annual report that dredging at this locality ... deferred until the completion of the project for the diversion of the Yazoo Riv... Upon the completion of the contract then existing, on July 3, 1893, the work ... dredging was suspended, and the repairs to Delta Point were made from the balan... of the available allotment. There is appended a report by Assistant Engineer H... St. L. Coppée upon the fill by deposit in the canal and basin since August, 1... *Levees, Lower Yazoo district.*—This district is situated on the east bank of the riv... and extends from the Bolivar-Coahoma county line (Mississippi), 265 miles be... Cairo, to the mouth of the Yazoo River. Levees have been constructed from th... upper end of the district to Eagle Lake, a distance by river of 215 miles. Th... length of the levee line is about 190 miles, and is under the local charge of th... Lower Mississippi levee board. The portion of the Yazoo Basin below Eagle Lak... has recently been organized into the Vicksburg levee district by the laws of th... State of Mississippi, but its board has erected no levees, nor does it possess th... power to levy taxes for their construction.

The standard section for levees adopted by the Lower Mississippi levee boa... has a width of crown of 8 feet, slopes of at least 1 on 3, a height 4 feet above th... flood of 1891, and backed by a banquette 8 feet below the crown, of a width ... from 20 to 40 feet, with a slope of 1 on 5. The levees constructed by the Unit... States have a similar cross section, but are built to a height 3 feet above the highe... known flood at the locality. Above Greenville the standard height adopted by th... General Government is higher than that of the local authorities; below Greenvil... it is lower.

At the close of the last fiscal year the levee line contained 17,371,291 cubic yar... of earth, of which 3,389,139 cubic yards had been put in place by the General Gov... ernment.

The allotment of $150,000 for the fiscal year ending June 30, 1894 (less 10 per ce... reserved for the high-water protection of levees), has been expended in enlargi... existing levees from the Bolivar-Coahoma county line (L 365) to Australia Lan... (stations 0 to 290); at Dennis Landing, L 373 (stations 406 to 580); from Concor... Landing, L 378, to Riverton, L 399 (stations 808 to 1422 and stations 1473 to 15... and at Leota, L 511 (stations 1784 to 2041). The length of levee line enlarged ... 27.1 miles, the enlargement containing 786,642 cubic yards. A tabulated statem... of the various contracts is appended.

A small force was also employed in repairing levees enlarged by the General Gov... ernment the preceding year which had been damaged by wave wash before it... had become properly sodded. The cost of repairs was $4,816.60.

From January 1, 1893, to January 1, 1894, the local authorities erected 877,12... cu... yards of earth, at a cost of $188,220.23, enlarging levees from stations 4727 to 47... above Greenville (L 476); below Greenville from stations 300 to 698 (L 484 to 49... stations 1200 to 1300 (L 497); stations 2587 to 2734 (L 530); stations 2979 to 30... (L 535), and stations 4168 to 4261 (L 556), a length of levee of 17.2 miles. N... levees have also been constructed near Greenville (L 477), at Shipland (L 545), ... Hayes (L 553), and at Brunswick (L 572), where caving banks threaten the destr... tion of the existing line. The length of abandoned levees is 18,250 feet, containi... 139,247 cubic yards. The yardage of levees in this district January 1, 1894, w... 18,895,814.

From the allotment of $150,000 for the fiscal year ending June 30, 1895, contracts have been awarded for the construction of new levees and enlargement work, as follows:

Levee.	Distance from Cairo.	Estimated yardage.	Price per cubic yard.	Total.	Contractor.
Australia:	*Miles.*		*Cents.*		
Upper section	L 371	150,000	9.75	$14,625	Timothy Sullivan.
Lower section	L 361	150,000	9.50	14,250	Do.
Buckridge	L 417	150,000	10.24	15,360	W. L. Withers & Co.
Eutaw to Mounds Landing	L 433	162,000	14.20	23,004	Starling & Smith Co.
Barnes Landing	L 477	38,000	11.98	45,524	Hugh McCarten.
Warfield Point	L 484	12,000	10.24	12,268	Do.
Hayes Landing:					
Upper section	L 553	125,000	9	11,250	Ben Talley.
Lower section	L 553	125,000	9.25	11,562	Do.
Chotard to Brunswick:					
Upper section	L 572	175,000	11.74	20,545	Leopold Aschaffenburg.
Lower section	L 572	175,000	13¼	23,406	J. H. Cary.

The work from Eutaw to Mounds Landing is the enlargement of the existing line. The remaining contracts are for new levees to replace portions of the line threatened with destruction from caving banks. The loop at Warfield has been completed, and contractors have begun operations below Australia, at Hayes and Chotard to Brunswick.

With the completion of the levees under contract the levee lines can be expected to resist floods which do not attain a height greater than that of 1893, the highest on record in this district; but with the rapid construction of levees on the opposite bank of the river increased flood heights can be anticipated.

By direction of the Commission a survey has been made of a levee line along the portion of the Vicksburg levee district in the Yazoo Basin. The extension of the levee system to the mouth of the Yazoo River would contain about 600,000 cubic yards. A levee of standard section from the south side of the Yazoo River to the West Pass of Centennial Lake would contain 400,000 cubic yards. Until the Yazoo River is diverted into Centennial Lake the construction of the levee south of the Yazoo River will be of no advantage to anyone, being flanked by the inflow through the mouth of the river. The extension of the levee to the mouth of the Yazoo would lower the back water at the present end of the line 3 feet if there is no increase in flood heights.

The levee line should be extended to the Yazoo River as soon as the existing levees have been made sufficiently strong to resist any flood to which they may be subjected, but the diversion of any of the allotments made for the Lower Yazoo levee district to that purpose is not recommended. While the Yazoo Basin has been preserved from overflow since 1891, it has been due to the weakness of the Arkansas levees, which have broken, lowering flood heights before those in Mississippi have been severely strained. During the floods of 1892 and 1893 between 25 and 30 per cent of the maximum flood discharge of the Mississippi River flowed across the Tensas Basin. By 1896 these conditions will be reversed; the strongest levees will be on the opposite bank of the river. The levees in the Upper Tensas district will be brought to standard section, and those of the Middle Tensas district, which are opposite those in the Lower Yazoo district. With an increased flood discharge to be anticipated, equal to the combined high-water flow of the White and Arkansas rivers, the lower Yazoo district is insecure.

While the increased flood heights of recent years have ruined the people at the lower end of the Yazoo Basin, a crevasse in the upper portion of the district, by raising the Yazoo River, would be as disastrous as the direct flow from the main river.

The principal beneficiaries from levees in the portion of the Vicksburg levee district contained in the Third district would be the inhabitants of Issaquena County, in the Lower Mississippi district, who would be protected from backwater which now passes around the end of the levee system, as shown in the accompanying map of the country overflowed in 1893.

The extension of the levees in the Yazoo Basin will also cause increased flood heights at the lower end of the Middle Tensas district, the portion of its levee line which is least secure.

Existing levees have never been able to control a great flood. The extension of the levee system should be deferred until the effect of the levees already constructed has been more definitely determined.

The work in this district above Greenville has been under the local charge of

Assistant Engineer J. D. Van Meter; that below Greenville, of Assistant Engineer E. C. Tollinger, both of whom have rendered efficient service.

A profile showing the height of levees constructed and under contract in this district accompanies this report, and the following is a report by Mr. William Starling, chief engineer of the Lower Mississippi levee district, of the yardage necessary to bring its levees to standard section.

Estimate of work to be done in the Mississippi levee district, May 11, 1894.

Stations.	Class of work.	Yardage.
Above Greenville:		
30 to 1663	Banquette	452,350
1663 to 1845	Enlargement	116,480
1845 to 2148	do	249,340
2148 to 3400	do	517,520
3400 to 3881	Banquette	325,240
3894 to 3970	Enlargement	54,900
3970 to 4270	do	207,000
4270 to 4550	do	201,600
4677 to 4910	Banquette	27,000
Greenville front	Enlargement	45,200
Total above Greenville		2,196,630
Below Greenville:		
0 to 2090	Banquette	312,250
2095 to 2195	Enlargement	46,000
2200 to 2900	Banquette	94,420
2900 to 2978	Enlargement	29,400
2978 to 3200	Banquette	53,000
3700 to 3808	Enlargement	21,600
3984 to 4102	do	62,540
4178 to 4379	do	94,470
4379 to 4716	do	78,840
Brunswick levee	Banquette	51,000
Total below Greenville		846,020
New levees:		
Waxhaw		127,560
Buck Ridge		304,640
Greenville		266,300
Warfield's		61,750
Shipland		124,400
Albemarle-Chotard		523,280
Total new work		1,408,830

RECAPITULATION.

	Yardage.
Enlargement above Greenville	2,196,630
Enlargement below Greenville	846,020
New work	1,408,830
Grand total	4,453,550

Levees, Upper Tensas district.—This district is situated on the west bank of the river and extends from the Arkansas River to the Louisiana-Arkansas State line. It is divided into three local levee districts, viz: The Red Fork levee district, which extends from the Desha-Lincoln county line (Arkansas) to the mouth of Cypress Creek; the Desha levee district, which extends from the mouth of Cypress Creek to the Desha-Chicot county line; and the Chicot levee district, which contains Chicot County. Above the Red Fork levee district along the Arkansas River is the Lincoln County levee district, which extends to the vicinity of Pine Bluff, Ark.

The State authorittes, prior to the war of the rebellion, had constructed a fine line of levees from Pine Bluff to the mouth of the Arkansas River. Since the war these levees have been neglected and damaged, not only by the elements, but by being used as a highway by people of the surrounding country until, in some cases, they have been cut down to the level of the ground.

Efforts have been made by local authorities to repair them from time to time, but the floods of 1890, 1892, and 1893 caused numerous crevasses, and not only overflowed the country along the Arkansas River, but, flanking the levees on the Mississippi River, added to the disasters of the entire Tensas Basin.

During the past season the local boards, assisted by the levee districts of Desha, Chicot, and Tensas in Louisiana and by the Iron Mountain Railroad, have closed all

breaks in their line above Red Fork, and topped all levees which were below the flood line of 1892. The flood of the Arkansas River of 1894, which attained a height of 24.8 feet at Little Rock, has been successfully controlled. Some water escaped through the crevasses below Red Fork into Cypress Creek, but it was not sufficient to cause an overflow into the Tensas Basin below.

The levees for protection against the Mississippi River begin at Amos Bayou, about 17 miles north of Arkansas City; extend along Cypress Creek to its mouth at Lucca Landing; thence along the Mississippi to the Louisiana State line. Their length is 84.8 miles.

The levees which have formerly been built by the local authorities have been of weak section, in many cases with a width of crown of but 4 feet, slopes of but 1 on 2, and of insufficient height. They are of defective construction, containing stumps, logs, and growing trees. The material for the levees has been taken from barrow pits too close to their base, which have become breeding places for crawfish and other burrowing animals whose holes have weakened an already weak base.

The levees built by the United States have been given a section similar to that adopted in the Lower Yazoo district, with the exception that banquettes have not been so extensively introduced, and when constructed have been given such dimensions as would contain the material in the base of the levee and in barrow pits which was not considered suitable for levee construction. The old State levees have been abandoned wherever practicable not only on account of their defects, but because the new levee was more economical, the reduction in the price per cubic yard more than compensating for the increased yardage required.

At the close of the last fiscal year there was in the levee line of this district about 5,643,000 cubic yards of material. The amount erected by the United States from 1882 to June 30, 1893, is 4,301,490 cubic yards. The levee line also contained 423,555 cubic yards erected by the Tensas levee district of Louisiana to standard section.

From the allotment of $300,000 for this district for the fiscal year ending June 30, 1894, $50,000 was reserved for the repair of old levees and their protection during the anticipated flood of 1894. The remainder of the allotment was expended in closing the crevasses that occurred during the flood of 1893, and replacing the weakest of the old levees by a line of standard section. The locations of the various works are as follows:

Name of levee.	Distance from Cairo.	Stations.	Cubic yards.	Remarks.
	Miles.			
Sains	423	* 223	139,674	Closing crevasse
Opossum Fork	427	* 317–335	109,380	New levee.
Bellview	465	95–127	24,745	Enlargement.
Pastoria	466	127–164	75,974	Do.
Dulaney	485	624–690	60,223	Do.
Leland	486	690–790	114,316	Do.
Vaucluse	487	833–863	56,155	Do.
Lakeport	493	1216–1369	99,738	Do.
Adams	498	50–306	429,008	New loop-closing crevasse.
Kigers	505	0–119	222,889	Closing crevasse.
Mathews Bend	509	0–37	100,916	Do.
Total			1,433,218	

* Cyprus Creek line.

A tabulated statement of the various contracts is appended.

The total length of new levees constructed and enlarged is 17.4 miles.

The length of levee line abandoned is 8.4 miles, containing 409,875 cubic yards.

During the fiscal year ending June 30, 1894, the Tensas levee district of Louisiana has constructed the new Eunice levee (R 448), containing 108,208 cubic yards, and enlarged the Fulton Lake levee (R 440), containing 217,293 cubic yards. The length of line constructed and enlarged is 5.3 miles. The levees abandoned have a length of 1.6 miles and contain about 66,000 cubic yards.

The Desha levee district has erected about 4,000 cubic yards of earth, enlarging about 1,000 feet in front of Arkansas City (R 438), but not to standard section. The Chicot levee board has expended $4,473.26, topping a levee below Sunnyside (R 491), and from Grand Lake to Sterling (R 510 to 515). The yardage contained in their work is unknown and immaterial, as it is expected that new loops will be constructed at both localities by the General Government before another flood.

Of the amount reserved for the repair and high-water protection of existing levees $26,457.92 was expended in topping levees, cutting out crawfish holes, cutting weeds, and repairing wave wash at localities given in a table appended.

By the united efforts of the local levee boards and the General Government the entire levee line was brought to a height of at least 1 foot above the flood line of 1893, but about 20 miles of levees would have been in a precarious condition if they had been exposed to a flood of the height and duration of either that of 1892 or 1893.

From the allotment of $300,000 for the fiscal year ending June 30, 1895, for this district, contracts have been awarded for the construction of levees as follows, viz:

Name of levee.	Distance from Cairo.	Station.		Yardage.	Price per cubic yard.	Total.	Contractor.
		From—	To—				
	Miles.				*Cents.*		
Red Fork*		0	190	228,000	7.75	$17,670	Manning & Gibson.
Boggy Bayou to Gaines Landing.	445–450	1320	1385	102,000	9.50	9,690	Tim Sullivan.
		1385	1460	116,000	8.74	10,138	M. McTighe & Co.
		1460	1518	120,000	10.00	12,000	Jas. Kennedy.
Panther Forest	451–465	0	27	173,000	19.75	34,167	Whitehill Co.
		27	54	165,000	17.85	29,452	Do.
		54	96	113,000	10.75	12,147	O. B. Crittenden.
Mathews Bend	508	0	30	126,000	16.25	20,475	Robt. Johnson.
		30	73	162,000	13.25	21,465	P. F. Lamb.
		73	115	133,000	9.98	13,273	Tim. Sullivan.
		115	162	156,000	11.99	18,704	Robt. Johnson.
Sterling to Louisiana line.	515–520	1038	1140	110,000	9.75	10,725	P. F. Lamb.
		1140	1212	90,000	11.75	10,575	L. C. Dulaney.

*On Arkansas River.

The levee to be constructed at Red Fork is for the purpose of protecting the head of the Tensas Basin from the floods of the Mississippi and Arkansas rivers.

Cypress Creek is the natural outlet of a network of bayous which drain the country south of the Arkansas River. When the reconstruction of the Arkansas levees was undertaken by the Mississippi River Commission in 1882, the levee line was extended along Cypress Creek to a point on Amos Bayou, which was then above overflow, but the numerous crevasses which have occurred in the Arkansas River levees and the raising of the flood plane of the Mississippi River by levee construction have caused a flow of water around the head of the levee system which would have inundated the country if there had been no breaks in the front line. The flow around the head of the levee system in recent years, as measured along the railroad from Arkansas City to Trippe, is as follows:

	Cubic feet per second.
1890	50,000
1891	5,000
1892	300,000
1893	97,000

The proposed Red Fork levee is to replace the portion of the Arkansas River levees abandoned by local authorities, and thus reduce the head on the upper portion of the Cypress Creek line. In addition to the levees contracted for under the allotment for the fiscal year ending June 30, 1895, 315,000 cubic yards have been placed under contract from the allotment for the fiscal year ending June 30, 1896. This will prolong the Arkansas River levees to Lake Jefferson, the point to which they extended in 1882.

To compensate for the rise in the flood height of the Mississippi River since that date, the Tensas levee district of Louisiana have under contract the extension of the Cypress Creek line about 5 miles up Amos Bayou, the yardage in the contract being 144,427, of which 100,000 cubic yards have already been constructed. This levee board is also enlarging the railroad embankment at Arkansas City (R 438), levee the enlargement containing about 110,000 cubic yards; its length, 7,600 feet.

In addition to the levees under contract there is an available balance from this and preceding allotments of about $90,000, which has been retained for high-water protection and to make provision for any crevasses which might have occurred in the flood of 1894.

With this sum all old State levees south of Cypress Creek can be replaced with levees of standard section. With the allotment of $300,000 for the fiscal year ending June 30, 1896, the entire levee line will be brought to standard section.

The work in the upper portion of this district has been in charge of Assistant Engineer J. J. Hoopes; that in the lower portion has been in charge of Assistant Engineer E. C. Tollinger; who have rendered efficient service.

The profile of levees constructed and under contract is shown on plat No. 3.

Statement of repair work in Upper Tensas levee district, 1893–'94.

Locality.	Distance from Cairo (R).	Kind of work.	Length.	Cost.
			Lin. feet.	
Amos Bayou to Station 1020	423–440	Weed cutting	93,500	$531.49
Lucca Loop (entrance to lake)	426	Topping	940	288.99
Lucca Loop	427	Heavy topping	2,100	546.00
Above Sain Loop	Station 200, Cypress Creek line	Light topping	1,900	240.80
Do	do	Muck ditch and side topping	835	615.61
Front of Opossum Fork, north	427	Heavy topping	565	116.50
Chicot City, front	431	Repairing heavy wave wash	3,000	1,179.53
Above Arkansas City	438	Muck ditch and side topping	200	93.00
Boggy Bayou to Gaines Landing	445–450	Topping, side topping, and muck-ditch.	1,200	271.68
Do	445–450	Topping	15,950	1,387.33
Do	445–450	Muck ditch and dressing	420	87.50
Panther Forest	451	Topping	5,400	706.22
Linwood	464	Wave wash	3,400	226.78
Do	464	Topping	6,100	364.94
Panther Forest	451	Repairing spur		8.00
Panther Forest and South Bellview.	451–465	Weed cutting	47,800	476.73
	465	Extra sodding	3,350	33.50
Bellview and Pastoria	465–466	Extension of traverses	5,000	72.00
Linwood short line	464	Topping	300	27.50
Panther Forest, lower end	465	Light topping	1,500	173.55
Do	465	Light side topping	700	243.45
Station 1858	454	Spur levee built	200	1,078.68
Station 1845–50	453	do	200	1,261.93
South from Panther Forest enlargement.	465	Light topping	4,500	415.75
Upper Leland, Lakeport, and Brooks mill.	469–496, 506	Weed cutting	20,668	90.50
Vaucluse	487	Side topping	2,795	913.35
Near Louisiana line	520	Cutting out craw fish holes		57.62
Upper Leland	469	Spur levee	1,228	1,612.23
Mathews Bend	508	Side topping	24,800	9,428.39
Grand Lake crossing	511	do	500	1,024.61
Below Grand Lake	512	do	5,300	1,617.41
Below Sterling	515	do	5,400	1,260.35
Total			259,751	26,457.92

Levees, Middle Tensas levee district.—This district is situated on the west bank of the river, and extends from the boundary line between the States of Arkansas and Louisiana to Bedford, La. It is a portion of the Fifth Louisiana levee district. The length of its levee line is 87.33 miles.

At the close of the last fiscal year there had been placed in its levees 7,286,927 cubic yards of material. The United States had erected, since 1882, 2,454,774 cubic yards.

With the allotment of $100,000 for the district for the fiscal year ending June 30, 1894, levees were constructed as follows:

Name of levee.	Distance from Cairo.	Length.	Yardage.
	Miles.	*Lin. feet.*	
Salem	565	9,025	242,163
Villa Vista	575	16,672	431,471
Total		25,697	673,634

These levees replaced portions threatened with destruction from caving banks. The length of line abandoned was 25,240 feet, containing 628,400 cubic yards.

During the year the Fifth Louisiana levee board and parish authorities have constructed about 1,052,000 cubic yards of levees at the following localities, viz:

Location.	Distance from Cairo.	Character of work.	Cubic yards (approximate).
Louisiana Bend	524	Enlargement and banquette in sloughs	150,000
Wilsons Point to Donna Vista	530–533.5	....do	220,000
Donna Vista to Longwood	533.5–536	Restoring wave-wash and banquette entire distance.	26,000
Longwood to upper end of New Elton (Government works, 1890–'91).	538	Enlargement and banquette entire distance.	51,000
Elton	540	Enlargement and banquette in sloughs	97,000
Hagaman	543	Enlargement 10 stations across lake	12,000
Hagaman to Wyly's	543–546	Banquette from Hagaman break to Wyly's.	23,000
		Enlargement Deesona levee, above Wyly's.	31,000
Wyly's	546	New levee, closing break of 1893	135,000
Wyly's to upper end of New Concord levee.	546–548	Banquette	80,000
Upper Wilton	560	Restoring wave wash and banquette in slough.	3,000
Alsatia	561	Banquette	10,000
Illawara	563	....do	21,000
Pecan Grove	566	Banquette and enlargement	43,000
Mascot to Omega	576–578	Enlargement	20,000
Willow Slough, above Youngs Point	592	Banquette	10,000
Youngs Point	593	New loop to cover cave	20,000
Delta Point	597	Enlargement and banquette	40,000
O'Brien and Towne levee	599	Banquette	28,000
Bigg's levee to upper end New Reid levee.	601–604	Enlargement and banquette	42,000
		Total	1,052,000

The yardage in levees abandoned by the work of local authorities is about 100,000. The total yardage in the levees at the close of the fiscal year is about 8,300,000.

Under the allotment of $100,000 for the fiscal year ending June 30, 1895, contracts have been entered into for the construction of the Reid levee (R 605) containing about 600,000 cubic yards. Work has been begun under the contracts and about 40,000 cubic yards erected to date.

The work in this district is under the local charge of Assistant Engineer W. S. Brown, who has rendered efficient service.

The levees in this district are built to a height of 3 feet above the highest flood, with width of crown of 8 feet. Levees recently constructed have slopes of 1 on 3, but in old levees, back slopes of 1 on 2½ are not infrequent.

Banquettes have not been as extensively introduced as in the lower Yazoo district, but the upper portion of the Fifth Louisiana levee district contains its strongest levees, while the lower portion of the Lower Yazoo district opposite it has not been raised to the standard section.

One of the serious problems in this district has been the destruction of its levee line by the caving banks of the river. Over 5,000,000 cubic yards of levee have been abandoned since 1882 from this cause, a length of levee line of 75.2 miles. The entire allotment of the General Government since 1890 has been expended in building new loops at localities where the existing levee has been threatened with destruction, and while the levee line is gradually being located in a more secure position, the expenditures for the purpose will be heavy for a number of years to come.

The flood of 1893.—At the date of my last annual report the flood of 1893 was at its maximum. From Arkansas City to Greenville its height exceeded any on record; from Greenville to Lake Providence the floods of 1892 and 1893 had about the same height; below Lake Providence the flood of 1892 slightly exceeded that of 1893. In the following table are given the maximum flood heights at the gauge stations in the Third District in 1882 and since 1890, together with those at Helena and Cairo and at Little Rock and Clarendon, while the crest of the flood was passing the mouth of White River:

Station.	1882	1890.	1891.	1892.	1893.	1894.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
White River	48.4	50.4	47.7	49.3	49.5	41.7
Arkansas City	47	49.5	48.2	49.9	50.3	40.5
Greenville	41.68	43.45	43.25	44.45	44.3	35.4
Lake Providence	38.32	41	41.1	41.9	41.5	34.4
Vicksburg	48.75	49	48.1	48.4	48.3	40.8
Cairo	51.87	48.8	46.2	48.3	49.3	37
Helena	47.2	47.7	44.7	45.7	47.9	38.1
Little Rock	25.7	23.9	17.7	28.2	27.2	22.7
Clarendon	.....	36.6	29	32.6	33.9	30.8

following are the maximum measured discharges and the estimated flow past titude of Lake Providence for the corresponding years:

[Cubic feet per second.]

Year.	Measured discharge.	Estimated flow.
	1,057,000	2,000,000
	1,288,000	1,720,000
	1,346,000	1,400,000
	1,430,000	1,760,000
	1,498,000	1,750,000

levees of the Lower Yazoo district successfully resisted the flood, but breaks red in the levees in the Tensas Basin at localities given in the following table:

Name of levee.	Distance from Cairo.	Date.	Width.	Discharge.
	Miles.	1893.	*Feet.*	*Cubic feet.*
	(*)	May 29	1,295	89,235
ort	496½	May 11	1,259	85,238
ews Bend	505¾	May 14	774	47,093
s	510	May 15	2,324	59,663
	515	May 23	2,900	230,193

* Station 202, Cypress Creek line.

ese crevasses, together with the water which escaped around the head of the system inundated the entire Tensas Basin, as is shown on the accompanying , the crevasse at Wylys being particularly destructive.

ith the subsidence of the flood these breaks in the levee line have been closed, one at Wylys by the fifth Louisiana levee board, the remainder by the General ernment.

1894, to date, the river has only attained a bank-full stage, and its maximum dis-ge has not been obtained.

rveys and observations.—Surveys have been made of the revetments at Lake var front, Greenville, Ashbrook Neck, Louisana Bend, and Delta Point. Hydro-phic surveys have been made during low water of Lake Providence Reach and reach at Greenville. During the flood of 1893 discharge observations were taken rkansas City and Wilsons Point and the results forwarded to the secretary of Mississippi River Commission. Discharge observations were also taken at Wil-s Point during low water, and the discharge of crevasses measured.

he flow across Ashbrook Neck and Carters Point during floods was also determined surveys and reconnoissances were made of the various "necks" in the vicinity Greenville to determine the effect upon them of the flood discharge. Where the ntry is covered with timber no scouring action could be observed, which is the e at Ashbrook Neck and Caulks Point, but across the cultivated fields of Carters nt a marked scour was noted, and across the necks in Arkansas above and below he flood discharge has flowed along the barrow pits of the levee line, in some ces scouring out holes which threaten the stability of the levee. It has been essary to build two spur dikes on the Panther Forest line to check this action, two on the line across Point Chicot.

With a further increase in flood heights, there is danger of a cut-off at Carters nt, particularly as the owner of the property has recently cleared certain por-ns of the neck of timber, which will tend to cause a concentration of the overflow its narrowest part.

Numerous surveys have been made in the different subdistricts to determine the ation of the various levees proposed, and in the Upper and Middle Tensas dis-cts the entire length of the levee line has been surveyed, and every ten stations rked by putting in the land slope of the levee a piece of ⅜-inch gas pipe, with 3-inch washer at its lower end, the top covered by a cap, on which is stamped S. B. M. and the number of the station.

During low water soundings were taken on the various crossings in the Third Dis-ct by such Government boats as were in commission. In the following table are ven the least depths obtained, and also those observed last season:

Crossing.	Distance from Cairo.	1893.	1892.
	Miles.	*Feet.*	*Feet*
Monterey	407	9½	8½
Caulks Point	415	9	10½
Catfish Point	424	9	8
Choctaw	432	9	12
Linwood	464	11½	11
Salona	474	13½	7½
Warfield	482	12	13½
Vaucluse	485	15	16½
Refugo	492	9½	9
Harwood	498	8½	14½
Lengwood	504	12	9
Leota	512	18	9
Sterling	515	12	5½
Cordell	526	13	14½
Wilsons Point	531	18	15½
Homochitta	535	13½	15
Lake Providence	544	9	12
Ajax Bar	546	9	5½
Arcadia	551	14	6
Duvalls	567	18	15
Henderson	574	12	12
Millikens Bend	585	12	.....
Paw Paw	588	12	.....

A marked improvement in the low-water channel is to be noted throughout the district, the shoalest crossing this season having 8½ feet, while in 1892 5½ feet was found both at Ajax Bar and Sterling.

The following are the extreme low-water records at the various gauges in the Third District:

	1893.	1892.
	Feet.	*Feet.*
Mouth of White River	7.7	6.5
Arkansas City	3.4	2.2
Greenville	3.4	2.1
Lake Providence	.8	.7
Vicksburg	.4	—1

A detailed report of the operations of the survey party will be found in the appended report of Assistant Engineer Arthur Hider.

Towing stone.—In the earlier operations in the Third District considerable difficulty was experienced in obtaining sufficient stone for the work. The sources of supply were quarries on the Upper Mississippi and the Ohio rivers, necessitating a long haul, which has added to the expense of the revetment.

In February, 1893, a contract was entered into for furnishing the stone required in the Third District during the calendar years 1893, 1894, and 1895; during high water the stone to be delivered on Government barges at quarries on the Little Red River at 49.9 cents per cubic yard; during low water the delivery to be on Government barges at Greenville, at 148.9 cents per cubic yard.

During the last fiscal year, $100,000 having been allotted for the purpose, 45,700 cubic yards have been delivered at Little Red River and towed to Louisiana Bend. A sufficient supply of stone has thus been accumulated so that the work can be vigorously prosecuted whenever it is considered advisable to resume operations.

The cost of towing has been about 50 cents per cubic yard. The cost of unloading has been from 6 to 17 cents, depending upon the stage of water at which the unloading was done.

The cost of a cubic yard of stone delivered on the bank at Louisiana Bend from Little Red River, including inspection, repairs to plant, towing, etc., is about $1.20, about one-half the cost of stone obtained from the upper quarries.

Care of fleet and repairs to plant.—The floating plant and other property when not in use has been collected and cared for about 1 mile below Greenville.

A statement in detail of the repairs to the various boats is appended, and also a list of floating property.

A financial statement accompanies this report.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain of Engineers.

Gen. C. B. COMSTOCK,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

APPENDIX 3 A.

REPORT OF ASSISTANT ENGINEER ARTHUR HIDER, UPON REPAIRS TO REVETMENT.

GREENVILLE, MISS., *March 15, 1894.*

SIR: The following report of the repairs made to the different revetment works at Lake Bolivar, Ashbrook Neck, Greenville, Louisiana Bend, and Delta Point during the low-water season of 1893, is respectfully submitted:

LAKE BOLIVAR FRONT.

This revetment as originally constructed in the fall of 1888 was 4,250 feet long; on the upper 3,300 feet the mats were 250 feet wide; at the lower end for a distance of 100 feet a single mat was built 180 feet wide.

The repairs projected were the construction of a mat 300 feet wide and 1,000 feet long over this narrow mat, and the repair of the upper bank by placing additional riprap to make the riprap the proper thickness at such places as needed to protect the bank.

Soundings taken over the work in July, 1893, indicate that there had been a fill over the entire space that was intended to be covered by this mat from 10 to 30 feet, since the work was originally built.

Work was begun September 13, 1893, and finished October 28, 1893, with a total length of 1,065 linear feet of mat made, 380 linear feet of which was lost in sinking the second mat.

Mat construction.—The usual method of mat building was followed, with the exception that the inner 100 feet (next the shore) was reenforced with an additional layer of brush placed at right angles to the bank. This was laid on top of the woven mat, and securely connected to it by wiring the cross and longitudinal poles placed on top of this layer of brush to those in the woven mat underneath. This gave a thickness of brush of nearly 2 feet in the 100 feet of mat next the shore, while the brush in the outer 200 feet was about 1 foot thick. The quantity of brush and poles used was 1.13 cords for each 100 square feet of surface.

It was contemplated at first to cover the entire space to be repaired with one continuous mat, but when about 550 feet of the mat had been built, the conditions were such that it was deemed advisable to limit the length of mat to 580 feet, on account of the danger in sinking a mat of such length in the rapid cross current, which developed as the river fell, due to the projecting of a hard "point" a short distance below. This current was inclined to the shore at an angle of about 30°, with a velocity of about 3¼ miles per hour.

The first mat, 580 feet long, was sunk in place without difficulty, and the second mat was built to a length of 485 feet; in sinking this, on account of the unusual strain to which it was subjected due to the conditions above stated, the cable splices pulled apart and about 380 feet of it was lost. The broken part was landed at Catfish Tow-Head and an effort made to strengthen it so it could be towed to Greenville and utilized, but owing to it being very heavily ballasted it began to sink before the necessary work could be done, and was abandoned.

The repairs when finished consisted of the building of 685 linear feet of mattress, and repairs to the upper bank revetment, as follows:

685 by 300 feet, equals 2,055 squares	$17,177.87
Repairs to old revetment	387.79
Total cost of work	17,565.66

The quantity of material used was as follows:

	Quantity.	Per square.
Brush, cords	3,135	.98
Poles, do	479	.15
Stone:		
Ballasting, cubic cards	1,020	.31
Sinking, do	695.3	.22
Wire, galvanized, pounds	1,757	5.50
Wire strand:		
Three-eighths-inch, do	2,339	.73
Five-eighths-inch, do	11,390	3.56
Spikes (wire)	2,400	.75

Statement of cost.

Revetment.	Unit cost of labor.	Unit cost of material.	Total unit cost.	Entire cost of work.
Mattress building (squares)	$2.16	$2.39	$4.55	$14,537.25
Towing				2,338.52
Office expenditures				9.70
Transportation				11.46
Property				164.50
Miscellaneous				113.50
Total				17,177.87

$17,177.87 ÷ 685 = $25.08 per linear foot. $17,177.87 ÷ 2,055 = $8.36 per square of 100 square feet.

Repairs to old revetment		$17,177.87
Cost of material	$265.42	
Labor	122.37	
		387.79
Total cost of repairs		17,565.66

Material.—The brush and poles were furnished under contract, loaded on barges from Dixie Bar. The stone was quarried and loaded on barges at Bee Rock, on Little Red River, in Arkansas. The towing to the site of the work was done by boats belonging to the Third District.

The work was finished October 23, 1893, and the working plant towed to Ashbrook Neck.

ASHBROOK NECK.

A careful examination of this revetment above the low-water line showed that it was in good condition, except a slough or settlement at station 105, due probably to a substratum of quicksand under the revetment washing out.

The stone was stripped from where this settlement had taken place, the depression filled up to grade with earth, and the riprap replaced. Additional stone was distributed along the upper bank revetment from stations 90 to 114, near the water's edge, to cover such parts of the slope where the brush work was exposed. This strip was about 50 feet wide. The amount of work covered in this manner was 2,400 feet by 50 feet, equal to 1,200 squares. Cost per square, $1.83. The quantity of material used was 972 cubic yards of stone.

Cost of the work.

972 cubic yards of stone	$1,122.66
1,026 bushels coal (fuel, towboat)	100.04
Labor	970.26
Total	2,192.96

Work was begun October 24, 1893, and finished October 28, 1893, when the plant was towed to Louisiana Bend.

GREENVILLE HARBOR.

An examination made of this revetment soon after the high water had subsided developed the fact that about the middle of the work there had been more or less cutting back of the natural bank above the level of the top of the stone revetment. The bank in places had washed out so as to leave a gully from 18 to 24 inches deep behind the revetment, along which the water flowed. This, if allowed to remain, would eventually do more serious damage.

There were also three or four other points where the stone revetment had settled down, caused by the water from heavy rains being concentrated and draining over the slope.

A more serious fault was the steepening of the under-water slope between dikes Nos. 6½ and 7½ and the caving back of the unprotected bank between dikes Nos. 7½ and 8½, in both cases due to eddy action caused by the projecting dikes above.

As no funds were available for the necessary additional mat work between these dikes, as recommended, the repairs were confined to resurfacing the washouts along the upper slope and repaving, using additional stone where necessary

The following is the cost of repairs made in July:

1,526.2 cubic yards of stone	$1,693.47
Labor	659.04
Total	2,352.51

In February, 1894, another settling or gullying of the revetment immediately slow dike No. 6¼ occurred after a very heavy rain. This was repaired at a cost of 166.49, viz:

0 cubic yards of stone	$55.51
abor	110.98
Total	166.49

The aggregate cost of repairs was $2,519.

During the rapid rise in February, 1894, indications of caving were observed at Dike No. 6¼; a special survey showed that the dike had settled down, also the foundation mat on which it rested. The settlement had been sudden, causing a sliding n of the upper bank revetment. This extended to a distance of about 500 feet above nd 300 feet below the dike. As near as can be determined from soundings the damage s confined within these limits.

There had been a rapid current along the front of this dike during the entire eason and a strong eddy current below. The dike was on a projecting "point" and was not able to withstand the action of the rapid currents above and below it.

The long line of revetted bank above will to a great extent mask the point of danger through the present season, and limit further caving to a comparatively small area during the next high water.

To render this part of the revetment secure it will be necessary to regrade and repave from 800 to 1,000 feet of the bank during the next low-water season and construct about 1,200 linear feet of mat. The estimated cost of this will be from $20,000 to $25,000. This work is urgent and should, if possible, be done the coming low water; otherwise the expense of repairs will increase to double or more should another high water intervene before the work is done.

LOUISIANA BEND.

The work proposed was the completion and extension of the system of brush dikes begun last season across the bed of "Old River" to check scouring behind the revetment, and a general repair of the damage done by the last high water.

The scour behind the revetment across the bed of "Old River" had increased, having extended beyond and cut around the shore ends of the dikes previously built, and had extended behind the revetment as far down as station 116.

It was decided to build five additional dikes and repair and extend the two constructed last season. These dikes were composed of brush and poles heavily ballasted with stone, and were constructed as follows: A covering of brush about 1 foot in thickness was laid on the ground, the brush being placed at an angle of 45° with the axis of the dike, with the butts projecting 8 feet above the upper wall of the dike; through this foundation of brush two parallel rows of posts were driven 8 feet apart; the posts were driven 4 feet in the ground and connected at the bottom by a heavy pole placed parallel with the axis of the dike; brush was than wattled between the posts to the required height, and the two walls connected by horizontal braces across the top; the space remaining was then filled in with brush and poles and heavily ballasted with stone.

The lengths of the respective dikes built were:

	Feet.		Feet.
No. 1	79	No. 5	166
No. 2	103	No. 6	129
No. 3	100	No. 7	144
No. 4	142		

Average width, 8 feet; height, 4.4 feet; length, 863 feet.

These dikes were placed at right angles to the bank, extending back from the inner edge of the revetment, and were spaced about 225 feet apart.

The material used per linear foot was:

Brush	cords..	0.286
Poles	do...	.576
Stone	cubic yards..	.767
Spikes	pounds..	.203

Cost per linear foot of dike, $3.27.

Repairs to revetment.—General repairs were made all along the line of revetted bank between stations 128 and 136. A series of small sloughs had taken place, due, it is believed, to seep water from the slough behind draining through and under the slope paving. These places were stripped of stone, resurfaced and repaved with spalls.

The ditch which was dug last season was lowered 2 feet to drain the slough behind the work, as this had scoured out during the last high water, and a box culvert 1 foot 8 inches by 1 foot 8 inches constructed which was covered with earth to a depth of 2 feet.

Additional stone was placed on the upper bank revetment in front of mat No. 6, built at the close of last season's work during a high stage of water; also a strip at station 95 was repaved.

Number of squares of riprap laid, 498.

Material.—Brush and poles were obtained by contract, and stone from the reserve at Louisiana Bend and from "Bee Rock" on Little Red River. The cost of loading stone from the reserve pile onto barges used in this work was 22½ cents per cubic yard.

One thousand five hundred cubic yards of stone were loaded for use at Delta Point.

The quantity of material used in these repairs was as follows:

Brush	cords..	302
Poles	do...	50
Stone	cubic yards..	2,227.2
Spikes	pounds..	400
Lumber	feet, B. M..	8,900

Statement of cost.

Kind of work.	Unit cost of labor.	Unit cost of material.	Total unit cost.	Entire cost of work done.
Building dikes ..... linear feet..	$1.613	$1.659	$3.27	$2,821.7
Bank paving ..... squares..	1.782	2.773	4.55	2,366.0
Cutting ditch ..... linear feet..	1.997	.270	2.27	1,043.6
Towing				706.54
Sundries				15.7
Total				6,858.65
Labor				343.2
Stone				376.7
Total cost of repairs				7,578.7

Condition of the work.—But little damage was done to the revetment during the last high water. The principal items of expense were the construction of additional dikes across the bed of "Old River," finishing the revetment with riprap left incomplete when mat No. 6 was built, and digging a ditch to drain the slough beyond the top of the bank about 500 feet to prevent further trouble from seep water.

Caving has been active all along the foot of the bend below the revetment; the entire strip that was cleared in 1892 has caved into the river.

Work was begun October 29, 1893, and finished November 16, 1893, and the plant towed to Delta Point.

DELTA POINT.

The work proposed was the construction of two mats 500 feet long and 300 feet wide around the point from station 4, upper, to station 4, lower base, and to revet portions of the upper bank where previous work had been destroyed. The working plant arrived from Louisiana Bend on November 18, 1893, and work was begun the following day.

On account of the rapid current, great depth of water, and exposed position the distance was covered with three mats instead of two, as originally intended.

The plan of construction was identical with that pursued at Lake Bolivar, except that on account of the exposed situation an extra number of cables were used. (The least number in any mat was fourteen ⅝-inch wire cables.)

The experience at Lake Bolivar led to an investigation of the strength of the "eye" splice heretofore used for joining the mat cables. This splice, when tested, failed by pulling apart before two-thirds of the ultimate strength of the cable itself had been reached. Of several different methods of splicing the "square knot" was adopted for connecting the cables; on trial this was found to be very nearly as strong as the cable itself.

A pile buttress was built at the head of the two mats first constructed to prevent the mats from swinging into shore while being sunk and more evenly distribute the strains. The configuration of the shore above rendered it impracticable to get a straight lead for the head cables holding the mat to the shore. The thrust developed against these buttresses was so great as to buckle the head of the mat, rendering it extremely difficult to sink the head near the shore and increasing the danger of loss in sinking.

For these reasons the buttress was omitted in the last of the mats constructed. In addition to these three main mats a pocket or shore mat was built where there had been a sloughing of the main bank about 200 feet below.

The mats built were of the following dimensions:

	Feet.	Squares.
No. 1	480 by 300	
No. 2	320 by 300	
No. 3	320 by 300	
	1,120 by 300 =	3,360
Shore mat	96 by 150 =	144
Total		3,504

The quantity of brush and poles used per square was 1.03 cords; stone, 0.74 cubic yards. Total cost per square, $4.88.

The accumulation of drift under the heads of these mats rendered necessary the use of more than the usual quantity of stone in sinking.

Repairs to bank revetment.—The greater part of the old revetment in front of where these mats were built had been destroyed from the low-water line up, caused in a great measure by the discharge of surface drainage over the slope. The depressions and settlements in the slope were filled in with earth, the bank regraded to a slope of 2 on 1, and revetted with stone 10 inches deep to an elevation of 36 feet on Vicksburg gauge.

Small ditches were cut along the top of the bank to confine the discharge of surface water to certain points at which paved drains were constructed for its passage down the slope.

The experience of the past two seasons demonstrates the necessity of making adequate provision for the carrying off of surface drainage, as to this cause a great deal of the damage to the revetment above the low-water line is undoubtedly due.

The cost of these repairs was $26.32 per linear foot of completed work.

Material.—Brush, poles, and piling were obtained by contract, delivered on barges; part of the stone was received from the quarries on Little Red River, and part loaded from the reserve pile at Louisiana Bend. The quantity of material used in these repairs was as follows:

Wire, galvanized	pounds	32,390
Wire strand, ¼-inch	do	1,419
Wire strand, ⅝-inch	do	23,996
Brush	cords	3,228.9
Poles	do	597.0
Stone	cubic yards	4,337.6
Spikes	pounds	2,070.0

Statement of cost.

Kind of work.	Unit cost of labor.	Unit cost of material.	Total unit cost.	Entire cost.
Mattress (squares)	$2.18	$2.70	$4.88	$16,390.25
Footmat (squares)	1.29	2.30	3.59	517.20
Paving bank	3.93	3.60	6.53	4,938.96
Grading	1.36	.....	1.36	895.25
Towing	.....	.....	.....	4,151.22
Traveling expenses	.....	.....	.....	32.25
Transportation	.....	.....	.....	50.30
Miscellaneous	.....	.....	.....	26.45
Total	.....	.....	.....	27,901.88

The work was finished January 19, 1894, and the plant towed back to the fleet at Greenville, Miss. The last of the plant arrived there on January 22, 1894, when the towboat *Emma Etheridge*, used during the season on repair work, was taken out of service and the crew discharged.

The repair forces at the different localities were under the direct supervision of George C. Thomas as superintendent of construction, who gave the work close attention, and displayed energy and judgment in its management, being ably assisted by W. M. Keller as clerk, and Martin Chrestensen and Benj. Baumgarden as principal foremen.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer in charge.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

Statement of cost, Lake Bolivar front.

Pay rolls, as per abstracts sent in		$6,650.52
Subsistence, as per list of bills (omitted)		2,708.12
Material:		
Stone, 1,945.3 cubic yards	$2,662.93	
Brush, 3,135.2 cords	3,291.96	
Poles, 497 cords	869.75	
Wire strand:		
2,339 pounds ⅜-inch	81.63	
18,158 pounds ½-inch	730.82	
Wire, galvanized, 22,000 pounds No. 12	547.80	
Wire spikes, 9,200 pounds	210.68	
Staples, 700 pounds	20.93	
Coal:		
Alabama, 10,247 bushels	999.08	
Pittsburg, 1,000 bushels	140.00	
Stationery	9.70	
Oils, 660 gallons	168.67	
		9,733.95
Traveling expenses		11.40
Medicines		43.30
Property; amount purchased as per list of bills (omitted)		329.00
Miscellaneous material:		
Lantern globes, 3 dozen	3.30	
Lantern burners, 4 dozen	1.20	
Lamp chimneys, 12 dozen	9.60	
Wicks, 1 gross	2.50	
Duck, 93 yards	9.30	
Grate bars (25)	72.00	
Gum, 20 feet	4.20	
Stone (Zeb Ward)	112.65	
Coal (E. G. Storey)	632.95	
		847.70
Gross amount charged		20,323.99
Credits:		
Subsistence stores on hands	874.71	
One-half value property purchased	164.50	
Material on hand, as per list (omitted)	973.52	
Coal (E. G. Storey)	632.95	
Stone (Zeb Ward)	112.65	
Balance, net cost of work	17,565.66	
		20,323.99

SUMMARY.

Pay rolls	$6,650.52
Subsistence	1,833.41
Material	8,779.63
Miscellaneous	102.10
Stationery	9.70
Traveling expenses	11.40
Medicines	14.40
One-half value property purchased	164.50
Cost of work done	17,565.66

EXPENDITURES.

Pay rolls, as per abstracts sent in	$6,650.52	
Subsistence, as per reports sent in	1,833.41	
		$8,483.93
Material:		
Stone, 19,453 cubic yards	2,662.93	
Poles, 497 cords at $1.75	869.75	
Brush, 3,135.2 cords at $1.05	3,291.96	
Wire strand:		
Three-eighths inch, 2,339 pounds, at $3.49	81.63	
Five-eighths inch, 11,390 pounds, at $3.49	397.51	
Galvanized wire, No. 12, 17,570 pounds, at $2.49	437.50	
Wire spikes, 2,400 pounds, at $2.29	54.95	
Coal:		
Alabama, 7,398 bushels, at 9¾ cents	721.31	
Pittsburg, 1,000 bushels, at 14 cents	140.00	
Oils, 512 gallons	122.09	
		8,779.63

Sundries:		
Miscellaneous material	$102.10	
Stationery	9.70	
Traveling expenses	11.40	
Medicines	14.40	
One-half value property purchased	164.50	
		$302.10
Total expenditures		17,565.66
Began work September 13, 1893; closed October 23, 1893:		
Number of days		41
Lost Sundays and other days		9
Number of working days		32

Labor employed.

Month.	General work.	
	Days.	Hours.
September	2,138	17,104
October	2,872	21,688
Total	5,010	38,792

Average, 5,010 + 32 = 157 men per day.
Total amount of pay rolls (not including subsistence), $6,650.52 + 38,792 = 17.2 cents per hour.

Subsistence.

Total amount expended	$1,833.41
Total cost of serving	373.70
Total cost served	2,207.11
Rations issued	6,688
Days labor secured	5,010
Daily cost for ration served	$0.33
Daily cost per ration, raw	.274
Daily cost per ration, days labor secured	.44

Material used.

	Quantity.	Per square.
Mat (3,195 squares built):		
Brush, cords	3,135.2	0.98
Poles, do	479	.15
Stone—		
Ballasting, cubic yards	1,020	.31
Sinking, do	695.3	.22
Wire, galvanized, pounds	17,570	5.5
Wire strand—		
Three-eighths inch, do	2,339	.73
Five-eighths inch, do	11,390	3.56
Spikes, wire, do	2,400	.75
Revetment (300 squares repaired):		
Stone, cubic yards	230	.26

	Quantity.	Per linear foot.
Mat (1,065 linear feet built):		
Brush, cords	3,135.2	2.94
Poles, do	479	.45
Stone, cubic yards	1,715.3	1.61
Wire, galvanized, pounds	17,570	16.5
Wire strand—		
Three-eighths inch, do	2,339	2.19
Five-eighths inch, do	11,390	10.70
Spikes, wire, do	2,400	2.25

Labor per linear foot of mat built.

38,300 hours' mattress work, per linear foot 35.9
492 hours' repair work, per square 1.9

Tabulated statement.

Kind of work.	Unit cost of labor and subsistence.	Unit cost of material.	Total unit cost.	Entire cost of work done.
Mattress work (squares)	$2.16	$2.39	$4.55	$14,537.[illegible]
Towing				2,338.[illegible]
Office expenditures				9.70
Transportation				11.40
One-half value property				164.50
Miscellaneous				116.50
Total				17,177.87
Repairs to old work:				
Cost of material				265.42
Labor and subsistence				122.37
Entire cost of season's work				17,565.66

Six hundred and eighty-five linear feet work completed (cost per linear foot completed includes loss of 380 feet mat), $17,177.87 + 685 = $25.08 per linear foot completed work.

GEO. C. THOMAS,
Superintendent Construction.

Statement of cost, Ashbrook Neck, October.

AMOUNT CHARGED.

Received from—	Articles.	Cost.
Emil Mayer	Supplies	$8.00
A. R. Taylor & Co	Stationery	14.97
Lake Bolivar Front	Subsistence stores	187.74
Do	Coal	277.7[illegible]
Delta Point, La	Stone	1,238.07
Employés	Pay, October, 1893	782.52
Gross amount		2,509.07

CREDITS.

Coal (1823 bushels) to Louisiana Bend, La	$177.73
Stone (100 cubic yards) to Louisiana Bend, La	115.41
Emil Mayer, supplies	8.00
A. R. Taylor & Co., stationery	14.97
Balance net cost of work	2,192.96
Total	2,509.07

AMOUNT EXPENDED.

Pay rolls, as per abstracts sent in	$782.52	
Subsistence, as per reports sent in	187.74	
		$970.26
Stone, 972 cubic yards	1,122.66	
Coal, 1,026 bushels	100.04	
		1,222.70
Total cost of repairs		2,192.96

Material used per square (1,200 squares repaired).—Stone, 972 cubic yards, equals 0.81 cubic yards per square.

Labor cost per square.—4,883 hours' repairs equals 0.74 per square.

One thousand two hundred squares revetment repaired, $2,192.96—1,200 equals $1.83 per square paving repaired.

GEO. C. THOMAS,
Superintendent Construction.

Statement of cost, Greenville Harbor.

Date.	Received from—	Articles.	Value.
r 1893	Employés	Pay roll	$586.84
gust, 1893	do	do	54.02
y and August, 93.	Little Red River	Stone, 1,526.2 cubic yards	1,093.47
Do	Headquarters	Subsistence	18.18
ruary 1894	Employés	Pay roll	108.36
Do	On bank below Greenville	Stone, 30 cubic yards	55.51
Do	Headquarters	Subsistence	2.62
Total			2,519.00

ARTHUR HIDER,
Assistant Engineer.

Statement of cost, Louisiana Bend.

y rolls, as per abstracts sent in		$3,472.10
bsistence, as per list of bills (omitted)		1,588.09
ush, 302 cords	$317.10	
les, 50 cords	87.50	
		404.60
one:		
2,227.2 cubic yards	2,692.55	
3,190.2 cubic yards (to Delta, La)	3,897.31	
13,855.5 cubic yards (left on bank)	16,926.58	
		23,516.44
ire, galvanized, 4,430 pounds	110.30	
ire strand:		
Three-eighths-inch, 5,439 pounds	189.82	
Five-eighths-inch, 6,768 pounds	333.31	
ire spikes, 6,800 pounds	155.73	
aples, 700 pounds	20.93	
		810.09
oal, 8,598 bushels		838.29
umber, 8,900 feet		89.00
ils, 254 gallons		59.04
iscellaneous:		
Spoons, 6	1.25	
Drugs	28.90	
		30.15
Gross amount charged		30,807.80

CREDITS.

tores to Delta Point, La	$864.10
laterial to Delta Point, La	1,468.01
tone to Delta Point, La	3,897.31
ledicine to Delta Point, La	14.45
ils to Delta Point, La	59.04
tone left on bank	16,926.58
Net cost work done	7,578.31
	30,807.80

EXPENDITURES.

Pay rolls, as per abstracts sent in	$3,472.10	
Subsistence, as per reports sent in	723.99	
		$4,196.09
Material:		
Stone—		
1,818.3 cubic yards	2,221.32	
408.9 cubic yards	471.23	
Wire spikes, 400 pounds	9.16	
Coal, 1,756 bushels	171.21	
Lumber, 8,900 feet	89.00	
Brush, 302 cords	317.10	
Poles, 50 cords	87.50	
		3,366.52

Miscellaneous:		
Property purchased	$1.25	
Medicine expended	14.45	
		$15.70
Total		7,578.31
Began work October 29, 1893; closed November 16, 1893:		
Number of days		19
Lost Sundays and other days		3
Number of working days		16

Labor employed.

Months.	General work.	
	Days.	Hours.
October	271	2,168
November	2,002	16,016
Total	2,273	18,184

Average, 2,273 ÷ 16 = 142 men per day.
Total amount of pay rolls (not including subsistence), $3,472.10 ÷ 18,184 = 19 cents per hour.

Subsistence.

Total amount expended	$723.99
Total cost of serving	$192.31
Total cost served	$916.30
Rations issued	2,231
Days labor secured	1,920
Daily cost per ration served	$0.41
Daily cost per ration raw	.324
Daily cost per ration days labor secured	.482

Material used.

	Quantity.	Per square.
Foot mat:		
Brush ..... cords..	69	0.20
Stone ..... cubic yards..	165	.48
Dike (69 squares built):		
Brush ..... cords..	233	3.38
Poles ..... do....	50	.72
Stone ballast ..... cubic yards..	624.8	9.06
Spikes ..... pounds..	175	2.54
Paving (158 squares repaired):		
Stone ..... cubic yards..	308.3	1.84
Revetment (498 squares paved):		
Stone ..... do	1,129.1	2.27

Ditch cut labor.

	Hours.	
	Total.	Per cubic yard.
3 by 4 by 400 feet, 6 by 8 by 170 feet, 480 cubic yards earth	2,481	5.2

Material used per linear foot of drain built.

[460 linear feet.]

	Quantity.	Per linear foot.
Lumber ..... feet..	8,940	19.35
Spikes ..... pounds..	225	.49

Stone loaded, 1,818.3 cubic yards—labor, 2,371 hours, = 1.3 per cubic yard.

Material used per 1 inch foot of dike built.

[863 linear feet.]

	Quantity.	Per linear foot.
rush.....cords..	302	0.35
oles.....do....	50	.06
one.....cubic yards..	789.8	.92
ikes.....pounds..	175	.20

Tabulated statement.

Kind of work.	Unit cost of labor and subsistence.	Unit cost of material.	Total unit cost.	Entire cost of work done.
uilding dikes (1 foot)	$1.613	$1.659	$3.272	$2,824.16
ank paving (squares)	1.782	2.773	4.555	2,268.23
utting ditch and building drain (linear feet)	1.997	0.270	2.267	1,043.02
owing				706.94
undries				15.70
Total				6,858.05
epairs to bank revetment:				
Labor on repairs				343.52
Stone on repairs				376.74
Total amount expended				7,578.31

GEO. C. THOMAS,
Superintendent Construction.

Statement of cost, Delta Point.

Pay rolls, as per abstracts sent in		$10,855.22
Subsistence, as per listed bills (omitted)		2,668.65
Material:		
Stone—		
From Louisiana Bend, 3,190 cubic yards	$3,897.31	
From White River, 773.3 cubic yards	2,473.34	
From last season, 374.1 cubic yards	665.90	
		7,036.55
Brush, 3,228.9 cords	3,390.34	
Poles, 597 cords	1,044.75	
Piles, 597 linear feet	52.50	
		4,487.59
Wire, galvanized, 37,430 pounds	932.00	
Wire strand—		
Three-eighths inch, 5,439 pounds	189.82	
Five-eighths inch, 24,596 pounds	955.51	
Staples, 700 pounds	20.93	
Wire spikes, 6,400 pounds	146.57	
		2,244.83
Coal—		
Alabama, 7,844½ bushels	767.33	
Pittsburg, 6,362 bushels	956 85	
		1,724.18
Medicines, amount from Louisiana Bend		14.45
Oils, 572 gallons		101.17
Miscellaneous:		
Cotton waste, 46 pounds	3.68	
Beeswax, 6 pounds	1.80	
Lumber, 144 feet, B. M	4.32	
Coal shovels, 2	2.50	
Pay, watchman on dredge	185.00	
		197.30
Transporting freight to steamers		50.30
Traveling expenses		32.25
Gross amount charged		29,411.49

CREDITS.

Subsistence stores to Arthur Hider	$113.64
Material to Arthur Hider	517.79
Stone to Ashbrook Neck	1,237.36
Stone to Louisiana Bend	355.89
Pay of watchman on dredge	185.00
Net cost of work	27,001.88

EXPENDITURES.

Pay rolls, as per abstracts sent in	$10,855.22	
Subsistence, as per reports sent in	2,555.01	
		$13,410.23
Material:		
Stone—		
773.3 cubic yards	880.16	
From Louisiana Bend, 3,190.2 cubic yards	3,897.31	
From last season, 374.1 cubic yards	665.90	
Wire spikes, 2,070 pounds	47.41	
Galvanized wire, 32,390 pounds	806.50	
Wire strand:		
Three-eighths inch, 1,419 pounds	49.52	
Five-eighths inch, 23,996 pounds	934.61	
Brush, 3,228.9 cords	3,390.34	
Poles, 597 cords	1,044.75	
Piles, 597 linear feet	52.50	
Coal, 13,456¼ bushels	1,613.18	
Oils, 572 gallons	100.17	
		13,482.35
Traveling expenses		32.25
Transportation		50.30
Miscellaneous material		12.30
Medicines		14.45
Total		27,001.88

SUMMARY.

Pay rolls	10,855.22
Subsistence	2,555.01
Material	13,482.35
Traveling expenses	32.25
Transportation	50.30
Medicines	14.45
Sundries	12.30
Cost of work done	27,001.88

Began work November 17, 1893; closed January 19, 1894:

Number of days	64
Lost Sundays and other days	16
Number of working days	48

Labor employed.

Month.	General work.	
	Days.	Hours.
November	1,665	13,320
December	4,517	36,136
January	1,989	15,912
Total	7,171	65,368

Average: 7,171 ÷ 48 = 149.5 men per day.
Total amount of pay rolls (not including subsistence), $10,855.22 ÷ 65,368 = 16.6 cents per hour.

Subsistence.

l amount expended	$2,555.01
l cost of serving	643.83
Total cost served	3,198.84
ions issued	9,058
s labor secured	6,926
ly cost per ration served	$0.0353
ly cost per ration, raw	.282
ly cost per ration, days labor secured	.455

Material used.

	Quantity.	Per square.
(3,360 squares built):		
Brush ..... cords..	3,068.9	9.13
Poles ..... do....	597	.117
Stone—		
Ballast ..... cubic yards..	1,444	.43
Sinking ..... do....	1,057.1	.31
Wire, galvanized ..... pounds..	31,670	9.42
Strand wire—		
Three-eighths ..... do....	819	.24
Five-eighths ..... do....	24,595	7.32
Spikes, wire ..... do....	1,990	.59
Piling ..... linear feet..	1,050	.31
t mat (144 squares built):		
Brush ..... cords..	160	1.11
Stone ..... cubic yards..	100	.7
Wire, galvanized ..... pounds..	720	5
Wire strand—		
Three-eighths inch ..... do....	600	4.17
Five-eighths inch ..... do....	600	4.17
Spikes ..... do....	80	.55
ak (656.5 squares paved):		
Stone ..... cubic yards..	1,836.5	2.8

Bank graded.

	Hours.	
	Total.	Per square.
bor required (656 squares)	2,785	4.25

Stone loaded.

	Hours.	
	Total.	Per cubic yard.
bor required (3,090.2 cubic yards)	516	0.6

Completed work.

MATERIAL USED.

	Quantity.	Per linear foot.
660.71 linear feet:		
Brush ..... cords..	3,228.9	3.03
Poles ..... do....	597	.56
Stone ..... cubic yards..	4,337.6	4.07
Wire, galvanized ..... pounds..	32,390	30.413
Wire strand—		
Three-eighths inch ..... do....	1,419	1.332
Five-eighths inch ..... do....	23,996	22.53
Spikes, wire ..... do....	2,070	1.94

Completed work—Continued.

LABOR.

	Hours.	
	Total.	Per linear foot.
Main work	65,368	61.3

Tabulated statement.

Kind of work.	Unit cost of labor and subsistence.	Unit cost of material.	Total unit cost.	Entire cost of work done.
Mattress (squares)	$2.177	$2.703	$4.88	$16,396.25
Foot mat (squares)	1.293	2.298	3.591	517.20
Paving bank (squares)	3.927	3.603	6.530	4,938.96
Grading bank (squares)	1.364	.....	1.364	385.25
Towing	.....	.....	.....	4,151.22
Traveling expenses	.....	.....	.....	32.25
Transportation	.....	.....	.....	50.30
Miscellaneous	.....	.....	.....	26.45
Total	.....	.....	.....	27,001.88

Linear feet work completed, 1,065. $27,001.88 + 1,065 linear feet = $26.321 per linear foot.

GEO. C. THOMAS,
Superintendent Construction.

APPENDIX 3 B.

REPORT OF ASSISTANT ENGINEER H. ST. L. COPPÉE ON SURVEY OF VICKSBURG HARBOR.

VICKSBURG, MISS., *May 19, 1894.*

SIR: I have the honor to submit the following report of changes in canal and basin in Vicksburg Harbor since August, 1893. As my time was limited, the sections were sounded about 300 feet apart instead of at 100-foot intervals as heretofore.

The following estimate of the fill due to deposit in the basin and canal is made approximately within the limits of the cross sections, as given in red on the sheets (3 to 1 on city side, and 4 to 1 on bar side in canal, and 3 to 1 on city side, and to a point 250 feet west of east edge of base of cut, in basin). On ranges 7+10 and 4 of basin the area was obtained a little beyond the limit of the red slope line on the city side, as there was a considerable slide from that bank. The areas of slough and fill, or "+" and "—" areas were obtained by a precision rolling planometer obtained through the courtesy of Capt. Willard and his assistants, which materially lessened my work, and giving accurate results (error 1.1000). The difference of these areas was taken as the area due to deposit. The yardage was obtained by averaging the end areas, and is as follows:

	Cubic yards.
Fill in basin, deposit	14,918
Fill in canal, deposit	68,168
Total fill in inner harbor	83,086

The following table gives the approximate average depth of fill since August, 1893, in bed of basin and canal, due to deposit and sloughing combined:

Depth of fill.

	East side.	West side.		East side.	West side.
BASIN.			CANAL—continued.		
No.—	*Feet.*	*Feet.*	Range No.—	*Feet.*	*Feet.*
	6	*3	23	7	7
	3	1	25	7	7
	5	2	28	7	†7
-10	3	1	30	7	†7
	3	2	34	7	†7
-10	3	†2	36	5	†7
CANAL.			39	7	†7
No.—			42	5	5
	2	7	45	7	5
	5	7	48	7	7
	5	8	50	7	5
	5	8	52	6	6
	5	9	54	7	7
	4	6	57	5	7
	5	7	59	0	0

*is is greatly due to slide north end of basin. † Greater in the middle.

e bed of the channel in the basin has an average elevation of from the zero of gauge t +2 feet for a width of about 50 feet.
e elevation of the base of the canal referred to the zero of the gauge for a width bout 50 feet is as follows:

Canal elevation at base.

ge—		Range—	
0+10	+1	No. 34	+8
No. 2	+5	No. 36	+6
No. 5	+5	No. 39	+8
No. 9	+6	No. 42	+7
No. 11	+7	No. 45	+7
No. 14	+7	No. 48	+7
No. 18	+7	No. 50	+7
No. 20	+7	No. 52	+6
No. 23	+6	No. 54	+5
No. 25	+7	No. 57	+2
No. 28	+7	No. 59	—6
No. 30	+8		

may be considered that the elevation of the base of canal is approximately to +7-foot plane.

Yours, respectfully,

H. ST. L. COPPÉE,
Assistant Engineer.

apt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

APPENDIX 3 C.

REPORT OF ASSISTANT ENGINEER ARTHUR HIDER ON SURVEYS.

GREENVILLE, MISS., *May 18, 1894.*

IR: The following report showing the operations of the survey party from June 893, to May 1, 1894, is respectfully submitted:

On June 1, 1893, two discharge parties were in the field, one at Arkansas City, in rge of T. C. J. Bailey, the other at Wilsons Point, under Charles H. Miller, chief party.

Mr. T. C. J. Bailey, who had charge of the survey party, resigned the position ly 1, 1893, and was succeeded by Mr. Charles H. Miller, under whose supervision e surveys after that date were made.

Below is given a synopsis of the work done.

FIELD WORK.

High-water discharge, Arkansas City.

Discharges measured, regular method, 150-foot stations 5
Discharges measured, flanking method 5
Measurement Cypress Creek Crevasse (R 428) 1
Measurement of flow across Ashbrook Neck (R 446–455) 1
Set of observations to determine vertical velocity curve 1

Field work finished June 9, 1893.

High-water discharge, Wilsons Point.

Discharges measured, regular method, 150-foot stations 7
Discharges measured, flanking method 7
Measurement Kiger Crevasse (R 505) 1
Measurement Grand Lake Crevasse (R 508) 1
Measurement Lakeport Crevasse (R 496) 1

Field work finished June 10, 1893.

Low-water discharge, Wilsons Point.

Discharge measured, regular method 1
Discharge measured, flanking method 1

Field work finished October 24, 1893.

SURVEYS OF REVETMENTS.

On July 15, 1893, a field party was organized for the purpose of taking soundings for comparison with former surveys over the revetment work at Bolivar, Ashbrook Neck, Greenville Harbor, and Louisiana Bend. These surveys were finished July 29, and the party disbanded.

Location of revetment.	Ranges sounded.	Soundings.
Ashbrook Neck	60	869
Greenville Harbor	110	1,[illegible]
Lake Bolivar	46	554
Louisiana Bend	29	353

The section of the bank above the water line was determined by leveling.

LOW-WATER SURVEYS.

Lake Providence Reach (L 517–549, 32 miles of river).—The party for this work was organized on September 19, 1893, and completed the survey, including soundings over that part of the Louisiana revetment built in 1891, and low-water discharge at Wilsons Point, October 24, 1893.

Ranges across the river established and sounded 92
Located soundings taken 2,483
△ stations occupied 32
△ stations repaired 20
△ stations erected (new) 12
Angles read in triangulation 111
Miles of new shore line located 29.6
Low-water discharge measured by regular and flanking methods 1
Ranges established and sounded over Louisiana Bend revetment 26
Located soundings taken 554

Greenville Reach (L 473–489, 16 miles of river).—This survey was begun October 26 and finished November 10, 1893, and the party disbanded.

Ranges across the river established and sounded 50
Located soundings taken 1,323
△ stations occupied 20
△ stations repaired 10
△ stations erected (new) 10
Angles read in triangulation 72
Miles of new shore line located 17.4

rrey of Carter's Neck (L 461–474).—On January 22 a small party was put in the and made a survey across the narrow part of the neck for the purpose of estab- ng points of reference for comparison with future surveys, to determine the ges taking place during high water and the tendency of the river to make a off at this locality. This survey was finished January 28, 1894.

line across the neck established 1
s sections at right angles to base line; profiles made of each 14

ecial survey of Greenville Harbor.—On February 19, 1894, soundings were taken ont of where Dike No. 6¼ stood, the dike having washed out a few days before the bank behind it having begun to cave.

ges established and sounded 13
ated soundings taken 145

DISCHARGE SECTIONS ESTABLISHED.

arch 13–21, 1894.—A party was organized to reestablish the discharge section at ansas City in 200-foot sections and permanently mark the location of the range.

ges established 21
ges established and elevations determined 6

pril 14–19, 1894.—Two experimental discharge ranges were established to deter- e the effect of form of cross section on discharges; one section was located about ile above Barnes Landing (L 476), in the middle of a bend, and the other at War- l Point (L 484), in a straight reach.

ges established 2
ges established and elevations determined 12
charge measured by regular method on same day at each station 1

Summary of field work.

charge observations	28
vasses measured	4
asurement of flow across Ashbrook Neck	1
of vertical velocity observations	1
ges set up	483
ated soundings taken	7,320
tations set up and repaired	52
gles read in triangulation	183
es of shore line located	53
pe gauges erected	12
es of duplicate levels	27
e line and cross sections across Carters Neck	1

Summary of office work.

mputations of discharge made	110
angles computed	62
stations, geographical positions determined	50
ps made	18
cings made	55
e prints made	600

RESULTS OF COMPARISON OF SURVEYS—CONDITION OF REVETMENT WORK.

Bolivar revetment (L 417–418—length, 4,400 feet).—A comparison of the survey of ne, 1889, with that of July, 1893, over the entire space covered by the original etment built in 1888, shows no scour through the mats themselves, but a consid- able fill. The average fill along the outside edge of the revetment was 16.8 feet. orty-five cross sections compared.)

Ashbrook Neck revetment (L 445–447—length, 9,330 feet).—Surveys of November, 1892, d July, 1893, compared.

There has been but little scour through the body of the mats. The average scour ong the outer edge of the revetment was found to be 9 feet. (Sixty cross sections mpared.)

Greenville Harbor revetment (L 477–479—length, 11,050 feet).—Revetment built in 91. Range 3 to 52, length 5,000 feet, surveys of November, 1891, and July, 1883, com- ared; practically no scour through mats; scour along outer edge of revetment, erage, 18.7 feet. Maximum scour range —51=30 feet. (Forty-seven cross sec- ons compared.) Revetment built in 1891. Range 53 to 70, length 1,600 feet; sur- eys of November, 1891, and July, 1893, compared; scour has taken place through

the mats and along the outer edge; average, 23.5 feet; maximum range, —61,48 feet. (Sixteen cross sections compared.)

The excessive scour along the outer edge and through the mats, range 58 to 70, shown by comparing survey of May, 1894, with July, 1893, after dike No. 6½ washed away, amounting to an average of 8.5 feet additional, makes the average scour along this section 32 feet, causing caving of the upper slope.

Revetment of 1892.—Range —6 to range +47, 5,300 feet; surveys of September, 1892, and July, 1893, compared; practically no scour through body of mats; average scour along the outer edge, 7.1 feet; maximum scour range, —29, 18 feet. (Fifty-three cross sections compared.)

Louisiana Bend revetment (L 521½–524½—length, 16,000 feet).—There has been a very considerable fill over the work done previous to 1891. A comparison of three sections taken over the revetment of 1891, surveys of November, 1891, and October, 1892, also shows a fill over the mats and along the outer edge. (Three cross-sections compared.)

Revetment of 1892.—Range 111+30 to 148, distance 3,730 feet; surveys of November, 1882, and July, 1893, compared; scour along the outer edge of revetment, average 14.9 feet; practically no scour through body of mats. (Eighteen cross sections compared.) Range, 150 to 168; length, 1,800 feet; surveys of November, 1892, and July, 1893, compared. There has been practically no scour through mats. The average scour along the outside of the revetment was 19.2 feet; maximum on range 154, 37 feet. (Ten cross sections compared.)

There has been no loss to any of the revetments by caving at the ends during the past season.

The above comparison of these different revetment surveys shows that while there has been a slight scour through the body of the mats in places, this action has not been of sufficient magnitude to injure the mats on any of the revetments (except along a portion of the Greenville front).

The scour along the outer edge of the revetments was to be anticipated, but it has not been so excessive as to prevent the mats adjusting themselves to the changed conditions arising from revetting a caving bank.

The deep scour along the outer edge and through the mats (range 58 to 70), Greenville front, is undoubtedly due to the old dikes No. 4½ and No. 6½, which, from the caving back of the original shore line in 1890, have since formed obstructions in the channel about 450 feet out from the present revetted bank, thus concentrating an unusual flow of water through this narrow channel between them and the shore and deepening it abnormally.

HIGH-WATER DISCHARGE.—COMPARISON OF ARKANSAS CITY AND WILSONS POINT DISCHARGE, MARCH–APRIL, 1893.

In these observations the discharge range was divided into 150-foot sections and the velocity measured with the meter at six-tenths of the depth in the middle of each 150-foot section. The discharge was also measured by allowing the boat to drift or flank slowly across the river with meter submerged to a uniform depth or 20 feet, thus integrating the different velocities in a horizontal plane through the section. Three separate computations of these discharges were made, viz:

(1) By dividing the discharge range into sections of 150 feet.

(2) By dividing the discharge range into sections of 300 feet.

(3) By computing the discharge as the mean of the flanking observations taken across the river in opposide directions, correcting for the boat's motion at every 150-foot section and reducing to mean velocity, using Price's vertical velocity table.

The same methods were used in computing the observations of May–June at Arkansas City and Wilsons Point, except that the 300-foot sections were not computed.

A comparison of the discharges obtained by the different methods is given in tabulated form, the Wilsons Point discharge being moved back one day to compensate for the time interval of water passing Arkansas City reaching Wilsons Point, the two stations being about 93 miles apart.

Comparison of discharge measurements, Wilsons Point with Arkansas City.

MARCH AND APRIL, 1893.

[Quantities given in cubic feet per second.]

Dates.		Discharge, 150-foot stations.		Difference.	Per cent.	Discharge, 300-foot stations.		Difference.	Per cent.	Discharge, flanking.		Difference.	Per cent.
Arkansas City.	Wilsons Point.	Arkansas City.	Wilsons Point.			Arkansas City.	Wilsons Point.			Arkansas City.	Wilsons Point.		
March 9		1,074,221				1,077,172							
	March 10		1,087,455	+13,234	+1.23		1,085,968	+8,796	+0.82				
March 10		1,067,695				1,084,992							
	March 13		1,082,616	+14,921	+1.40		1,067,449	−17,543	−1.62				
March 13		1,157,616				1,121,511							
	March 14		1,085,220	−72,396	−6.25		1,063,220	−58,291	−5.20				
March 20						981,648							
	March 21						*1,008,472	+26,824	+2.73				
March 21		1,018,943				1,020,169							
	March 22		984,761	−34,182	−3.35		975,843	−44,326	−4.34				
March 22		1,024,552				1,018,283							
	March 23		981,799	−42,753	−4.17		986,037	−32,246	−3.17				
March 24		977,110				968,078							
	March 25		964,968	−12,142	−1.24		960,129	−7,949	−0.82				
March 27						968,032					964,100		
	March 28						970,266	+2,234	+0.23				
March 29		929,375				929,586					945,958	−18,142	−1.88
	March 30		940,261	+10,886	+1.17		948,909	+19,323	+2.08				
March 30		963,539				967,002							
	March 31		973,391	+9,852	+1.02		970,069	+3,067	+0.32				
March 31		923,491				938,766							
	April 1		947,591	+24,100	+2.61		943,292	+4,526	+0.48				
April 3		876,031				883,942					869,383		
	April 4		898,544	+22,513	+2.57		904,706	+20,764	+2.35			+24,861	+2.85
April 4						857,013					845,995		
	April 5						855,296	−1,717	−0.20		840,410	−5,995	−0.78
April 5						823,285					842,991		
	April 6						849,806	+26,521	+3.29		852,816	+9,825	+1.16
April 6		777,674				773,494					781,089		
	April 7		840,510	+62,836	+8.08		846,167	+72,673	+9.40		825,375	+44,286	+5.67
April 7						753,466					736,505		
	April 8						796,785	+43,319	+5.75		774,691	+38,186	+5.18

* Floats.

Comparison of discharge measurements, Wilson Point with Arkansas City—Continued.

MAY AND JUNE, 1893.

Dates.		Discharge, 150-foot stations.		Difference.	Per cent.	Discharge, flanking.		Difference.	Per cent.
Arkansas City.	Wilsons Point.	Arkansas City.	Wilsons Point.			Arkansas City.	Wilsons Point.		
May 5		1,256,236							
	May 6		1,286,982	+30,746	+2.45				
May 8		1,351,939				1,405,198			
	May 9		1,401,272	+49,333	+3.65		1,398,419	−6,779	−0.48
May 9		1,436,508				1,420,549			
	May 10		1,387,414	−49,094	−3.42		1,382,542	−38,007	−2.67
May 10		1,460,645				1,452,214			
	May 11		1,434,694	−25,951	−1.78		1,416,978	−35,236	−2.43
May 11		1,479,821				1,469,634			
	May 12		1,460,852	−18,969	−1.28		1,478,330	+8,696	+0.59
May 12		1,469,730				1,472,332			
	May 13		1,482,752	+13,022	+0.89		1,488,224	+15,892	+1.08
May 15		1,528,626				1,493,888			
	May 16		1,491,507	−37,119	−2.43		1,512,816	+18,928	+1.27
May 16		1,506,729							
	May 17		1,497,910	−8,819	−0.58				
May 17		1,481,714				1,457,054			
	May 18		1,533,431	+51,717	+3.49		1,549,660	+92,606	+6.36
May 18		1,498,136				1,503,015			
	May 19		1,562,212	+64,076	+4.28		1,566,158	+63,143	+4.20
May 19		1,471,092				1,534,958			
	May 20		1,563,011	+91,919	+6.25		1,564,773	+29,815	+1.94
May 22		1,463,914				1,522,091			
	May 23		1,571,336	+107,422	+7.34		1,580,618	+58,527	+3.85
May 23		1,502,844				1,498,706			
	May 24		*1,629,197	+126,353	+8.41		*1,656,460	+157,754	+10.54
May 24		1,541,061							
	May 25		1,567,315	+26,254	+1.70				
May 26		1,490,262				1,571,039			
	May 27		1,608,135	+117,873	+7.91		1,612,180	+41,141	+2.62
May 29		1,630,708				1,613,474			
	May 30		1,555,940	−74,768	−4.59		1,604,348	−9,126	−0.57
May 31		1,593,642							
	June 1		1,589,282	−4,360	−0.27				
June 1		1,570,850				1,544,181			
	June 2		1,539,155	31,744	2.02		1,552,087	+7,906	+0.51

June 2	June 3	1,567,348	1,570,839	+3,491	+0.22	1,587,499	1,533,236	−54,263	−3.42
June 5	June 6	1,537,791	1,551,880	+14,089	+0.92	1,552,275	1,532,130	−20,145	−1.29
June 7	June 8	1,520,277	1,551,378	+31,101	+2.04	1,500,218	1,532,942	+32,724	+2.18

* Not used in comparison.

Crevasse at Wyly's occurred May 23, 11 a. m.

RESULTS FROM COMPARISONS.

Discharge at Arkansas City compared with discharge at Wilsons Point, the latter moved back one day:

Observations of March–April, 1893.

	Per cent.
11 observations compared, discharge computed in sections 300 feet in width:	
Mean per cent of difference	2.7
Maximum difference from	+9.40 to −5.2
The same 11 observations compared, discharge computed in sections 150 feet in width:	
Mean per cent of difference	3.01
Maximum difference from	+8.08 to −6.2
6 observations compared, discharge computed in sections 300 feet in width:	
Mean per cent of difference	3.54
Maximum difference from	+9.40 to −0.2
The same 6 observations computed using the flanking method:	
Mean per cent of difference	2.92
Maximum difference from	+5.67 to −1.8

Observations of May–June, 1893.

16 observations compared, discharge computed in sections 150 feet in width:	
Mean per cent of difference	3.28
Maximum difference from	+7.91 to −4.5
The same 16 observations compared, computed, using flanking method:	
Mean per cent of difference	2.22
Maximum difference from	+6.37 to −3.42

In the March–April observations at Arkansas City there are 3 observations, and at Wilsons Point 1, where the mean obtained by the flanking method is greater than obtained by the regular method by a fraction of 1 per cent.

The increment due to lateral flow derived from the flanking observations at Arkansas City was on an average 1.43 per cent, and at Wilsons Point 1.28 per cent.

In the May–June observations at Arkansas City there are 6 observations, and at Wilsons Point none, where the mean obtained by the flanking method is greater than the discharge obtained by the regular method. This excess varies from 0.46 to 4.84 per cent in these 6 observations.

The increment due to lateral flow derived from flanking observations at Arkansas City was 1.93 per cent and at Wilsons Point 2.45 per cent. In these observations crevasses have been included in the comparison.

In comparing the discharges obtained at the two stations it will be seen from the above that the percentage of difference is less by the flanking than by the ordinary method. The flanking method eliminates the excess measured by the meter due to lateral flow, and as the time required by the regular method for the field work is about three times as long as that consumed in flanking, it is entirely practicable to obtain four or five discharges at the same point by the same party in one day.

A set of observations to determine the vertical velocity curve at high water was taken, which, when plotted, shows a wide divergence from that derived from Price's tables. Further data on this is desirable, as the accuracy of the flanking method depends on the correct relation of velocities at different depths to the mean velocity.

The reports of the observers, heretofore submitted, give a very full description of the methods employed and the results obtained.

CAVING BANKS.

The following statements show the length, and distance back, of the caving that has taken place in the Greenville Reach, 473–489 (16 miles of river), and Lake Providence Reach, 517–549 (32 miles of river), low-water surveys of 1892 and 1893 compared:

GREENVILLE REACH.

Locality.	Length of caving.	Maximum depth.	Average depth.
	Feet.		
Bachelors Bend (left bank)	23,000	250	12
Bachelors Tow-Head, foot of (right bank)	7,500	280	15
Warfield Point and Tow-Head (left bank)	7,000	90	3
Tow-head above Leland (right bank)	5,500	500	30
Walker's Bend below Vaucluse (right bank)	10,000	300	2

Total length of caving, main shore, 47,500 feet, or nearly 9 miles. Maximum caving 200 feet in depth Walkers Bend (right bank). Mean caving 146 feet in depth. Left bank, 30,000 feet; right bank 17,500 feet.

LAKE PROVIDENCE REACH.

Locality.	Length of caving.	Maximum depth.	Average depth.
	Feet.		
posite Carolina Landing (left bank)	8,000	400	240
erty Point (left bank)	11,000	600	275
isiana Bend, lower end (right bank)	5,000	600	320
dell to Duncansby (left bank)	32,000	320	120
tonwood (right bank)	3,000	80	40
mochitta (left bank)	13,000	420	180
Lomond to Shipland (left bank)	13,000	1,240	340
ove Lake Providence (right bank)	21,000	720	240
id below Lake Providence (right bank)	20,000	400	150

Total length of caving, main shore, 126,000 feet, equal to 23.9 miles. Maximum caving, 1,240 feet, Shipland, left bank; mean caving, 201 feet in depth; left bank, 77,000 feet; right bank, 49,000 feet.

Crevasse measurements.

CYPRESS CREEK CREVASSE (R 428).

Date of—		Width.	Mean velocity.	Discharge per second.	Gauge reading.
Crevasse.	Measurement.				
		Feet.	*Feet.*	*Cubic feet.*	
ay 29	June 6	1,090	3.59	89,235	Arkansas City, 49.55.

LAKEPORT CREVASSE (R 496).

ay 11	May 18	618	5.47	64,726	Greenville, 43.8.
	19	803	4.39	85,238	Greenville, 44.1.
	June 10	1,259	3.44	69,493	Greenville, 43.2.

KIGER CREVASSE (R 505).

May 14	May 20	339	1.43	14,871	Greenville, 44.0.
	June 9	774	3.28	47,093	Greenville, 43.8.

MATHEWS BEND CREVASSE (R 508).

May 15	May 20	560	3.32	18,235	Greenville, 44.0.
		989	4.12	41,428	Greenville, 44.0.
		1,549		59,663	Measured in two parts.
	June 9	652	2.76	14,115	Greenville, 43.3.
		1,672	1.72	24,469	Greenville, 43.3.
		2,324		38,584	Measured in two parts.

WYLY'S CREVASSE (R 545).

May 23	May 26	2,300	4.91	209,010	Wilsons Point, 39.6.
	29	2,950	6.40	230,193	Wilsons Point, 39.3.

Flow across Ashbrook Neck (L 446–456).—Length along axis of neck perpendicular to flow, 24,000 feet. Average depth, 5.4 feet; average surface velocity, 1.54 feet per second; mean velocity, taken at nine-tenths or 1.39 feet per second. Flow across neck, 171,470 cubic feet. Measured June 8, Greenville gauge, 43.4.

Flow across Carters Neck (L 461–474).—Length of base on which measurements were made, 22,220 feet; average depth, 5.7 feet; mean velocity, 2.07 feet per second. Discharge, 262,174 cubic feet. Length of base, 8,000 feet. Average depth, 6.4 feet; mean velocity, 1.11 feet per second. Discharge, 56,832 cubic feet. Total discharge, 319,006 cubic feet per second. Measured May 25, Greenville gauge, 44.2.

The expense of the party was as follows:

Salaries officers and laborers	$7,664.80
Subsistence	1,261.91
Supplies, including fuel for steamers	308.58
Total	9,235.35
Amount charged to high-water discharge	1,848.45
Cost of surveys proper	7,386.90

In concluding the report of the operations of the survey party, I desire to express my appreciation of the ability and care displayed by Mr. Charles H. Miller in carrying out the different surveys, and to his assistants, Mr. P. L. Low, L. L. Griffiths, and Stevenson Archer, jr., for faithful and efficient service.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

APPENDIX 3 D.

STATEMENT SUBMITTED BY U. S. ASSISTANT ENGINEER ARTHUR HIDER, OF REPAIRS TO PLANT, THIRD DISTRICT, IMPROVING MISSISSIPPI RIVER, MAY 1, 1893, TO APRIL 30, 1894.

Steamer *Emma Etheridge.* New pillow blocks; ordinary repairs to hull, cabin, and machinery during the seasou	$1,119.01
Steamer *Osceola.* New guards and nosing; ordinary repairs to cabin and hull; repairs to boilers and machinery during the season; painted	1,989.93
Steamer *Vidalia.* Ordinary repairs to cabin and hull; new cylinders and repairs to machinery; new mud drum; painted	2,265.73
Steamer *Vedette.** Put on dock and break in bottom repaired; ordinary repairs to hull and machinery during the season; painted	808.84
Steamer *Meter.** Docked and general overhauling; frames, rakes, and side plank renewed where necessary; machinery overhauled; general repairs; painted	1,257.78
Tug *Parker.* Hull rebuilt; repairs to cabin and machinery; new wheel; painted	4,843.51
Model barge *Apache.* Calked above light water; deck repaired	127.08
Model barge *Cheyenne.* Calked above light water; decked and hog chains repaired	200.14
Model barge *Chinook.* Calked above light water; broken frames and plank repaired; repairs to deck	148.53
Model barge *Comanche.* Calked above light water; repairs to deck	78.18
Model barge *Maricopa.* Calking and minor repairs	38.94
Model barge *Mohave.* Repairs to sides; calking and repairs to deck	321.77
Model barge *Nez Perce.** Put on dock; barge rebuilt; new frames, sides and bottom, main keelson	3,805.83
Model barge *Piute.* Calked above light water; repairs to deck	78.21
Model barge *Shoshone.* Calked above light water; sides and deck repaired.	317.70
Model barge *Uintah.* Plank on sides set up and respiked; calked above light water	215.79
Grader No. 1. Calked above light water and cabin repaired	107.11
Grader No. 3. Deck and rakes calked; cabin repaired; new liner for air pump	121.83
Grader No. 77. Deck and rakes calked; repairs to cabin	78.61
Quarter boat No. 16. Minor repairs	16.04
Quarter boat No. 17. Deck, outside of cabin, and rakes calked	38.45
Quarter boat No. 19. Minor repairs	7.00
Quarter boat No. 31. Repairs to guards; minor repairs and calking above light water; steam pump and pipes in hold overhauled and repaired	260.21
Machine shop No. 222. Deck calked; ventilators cut in hull; general repairs to machinery and tools during the season; fire pump repaired and set up	376.51
Pile-driver No. 31. Machinery overhauled	21.00
Pile-driver No. 32. Machinery overhauled; new furnace; decks, sides and rakes calked	147.48

le-driver No. 33.	Same	$166.72
le-driver No. 49.	Same	128.91
le-driver No. 34.	Same	140.19
le-driver No. 54.	Same	70.76
at boat No. 32.	Sides calked and extra chains put in; ways repaired	97.87
at boat No. 33.	Same	130.61
mp scow No. 2.*	Put on dock; rotten plank in rakes taken out; sheathing in wells renewed where rotten; sides and deck calked	849.76
arge No. 79.	Calked above light water	39.63
arge No. 8.	Same	36.50
arge No. 82.	Same	39.6
arge No. 84.	Same	53.62
arge No. 108.	Minor repairs	9.08
arge No. 135.	Calked above light water	41.31
arge No. 136.	Same	34.05
arge No. 137.	Same	34.78
arge No. 138.	Repairs to deck	20.55
arge No. 530.	Same	18.56
arge No. 534.	Same	12.40
arge No. 535.	Repairs to deck	28.66
arge No. 542.*	Docked; sides, deck, and rake repaired; calked	191.80
arge No. 542.*	Same	104.18
arge No. 543.*	Docked; rakes repaired	34.84
arge No. 545.	Calked; new hatch covers and pump	90.79
arge No. 547.	Same	98.00
arge No. 548.	Calked; repairs to rake	44.05
arge No. 549.	Calked above light water	42.27
arge No. 550.	Calked above light water; repairs to rakes	121.81
arge No. 204.	Calked above light water	47.04
arge No. 225.	Same	42.67
arge No. 544.*	Docked; calked above light water, and repairs to rake	87.36
arge No. 230.	New deck, timberheads, sides, and rakes; calked above light water	640.52
Barge No. 212.	Minor repairs	1.75
Barge No. 201.	Repairs to sides and deck; recalked above light water	314.38
Barge No. 217.	New head block; repairs to deck, and recalked above light water	124.19
Barge No. 214.	Repairs to sides and deck; recalked above light water	243.68
Barge No. 220.	Repairs to sides and deck	27.58
Barge No. 226.	Calked sides and rakes; deck repitched	95.78
Barge No. 174.	Repairs to rake	21.72
Barge No. 188.	Calked above light water	57.98
Barge No. 538.	Same	37.85
Barge No. 532.	Minor repairs	.87
Quarter boat No. 38.*	Docked; new gunwales, floor timbers, rakes, deck at each end, head blocks and timberheads calked	714.77
Quarter boat No. 60 (named *Louisiana*).	Calking and repairs to cabin	33.03
Quarter boat No. 158.*	Docked; new bottom gunwales both sides; new steamers and rakes, and guards; cabin from old quarter boat No. 36 moved over and fitted with kitchen and dining outfit for mechanics' mess boat	983.83
Quarter boat No. 88.	Repairs to guard stanchions	2.62
Quarter boat No. 86.	Calked above light water	37.11
Quarter boat No. 87.	Same	32.70
Quarter boat No. 142.	Minor repairs	6.30
Quarter boat No. 154.	Calked above light water	40.48
Quarter boat No. 155.	Deck and sides above light water calked; ranges and kitchen outfit repaired	89.69
Quarter boat No. 156.	Deck calked; ranges and kitchen outfit repaired	40.09
Quarter boat No. 157.	Repairs to guard stanchions	2.62
Quarter boat No. 159.	Minor repairs	.87
Property boat No. 85.	Repairs to inside	28.28
Carpenter shop No. 78.	Deck calked; repairs to machinery; new stack for boiler	142.09
Barge No. 175.	Minor repairs	1.75
Barge No. 110.	Same	14.17
Barge No. 531.	Same	1.31
Barge No. 47.	Same	3.94
Fuel barge E.	Calked above light water	12.68
Fuel barge A.	Same	64.53

Store boat. Minor repairs	$8.75
Dry dock. Calked above light water; new cushion for apron; all pipes and pumps overhauled; new valves for rotary pumps; minor repairs to machinery during the season	292.04
Dredge *Menge*. Minor repairs	29.37
Total cost	25,894.76

Boats marked "*," 10 in number, have been docked.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer.

GREENVILLE, MISS., *May 22, 1894.*

APPENDIX 3 E.

Cost of levees in the third district, built and enlarged by the United States, from 1882 to May 31, 1894.

MISSISSIPPI.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch-to-mile map.
1882–1893...	Levee construction		3,445,139	$785,172.22	
1882–1893...	High-water protection, repairs, and engineering expenses.			135,313.44	
1893.....	Station 0 to 290	Starling & Smith Co	124,238	23,605.22	L 395
1893.....	Station 406 to 580	W. L. Withers & Co	79,149	14,642.56	L 37[illegible]
1893.....	Station 808 to 900	do	81,065	14,389.03	L 3[illegible]
1893.....	Station 900 to 1,000	Timothy Sullivan	77,393	14,704.67	L 3[illegible]
1893.....	Station 1000 to 1200	Starling & Smith Co	127,568	22,962.24	L 3[illegible]
1893.....	Station 1200 to 1291	Arnold, De Garis & Co	119,202	19,519.31	L [illegible]
1893.....	Station 1291 to 1422	W. L. Withers & Co	73,696	12,712.56	L 3[illegible]
1893.....	Leota	Merritt Williams	52,276	7,574.78	L 51[illegible]
1893.....	Rosedale, Station 1473 to 1572+58.	Bogue & Co	51,055	7,339.16	L 3[illegible]
	High-water protection, repairs, and engineering expenses to May 31, 1894.			24,684.68	
	Total cubic yards to May 31, 1894.		4,230,781		
	Total cost to May 31, 1894.			1,082,619.87	

Cost of levees in the third district, built and enlarged by the United States, from 1882 to May 31, 1894.

ARKANSAS.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch-to-mile map.
1882–1893...	Levee construction		4,301,490	$908,946.02	
1882–1893...	High-water protection, repairs, and engineering expenses.			200,761.68	
1893.....	Opossum Fork, Station 374–414.	Starling & Smith Co	109,380	22,969.80	R 436
1893.....	Bellview, Station 95–127.	Arnold, De Garis & Co	60,228.2	9,411.16	R 465
1893.....	Pastoria, Station 128–164	The Whitehill Co	75,974	15,194.80	R 466
1893.....	Dulaneys Loop, Station 624–689.	Ernest Hyner	60,223	9,599.54	R 486

ost of levees in the third district, built and enlarged by the United States, from 1882 to May 31, 1894—Continued.

ARKANSAS—Continued.

ear built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch-to-mile map.
93.....	Leland, Station 690–790.	Ernest Hyner	114,516	$21,689.33	R 485
93.....	Vaucluse, Station 832–862.	McLaughlin Bros	56,155	15,161.85	R 487
93.....	Lakeport, Station 1216–1291.	Jas. S. Peak.....	42,118	5,054.16	R 495
93.....	Lakeport, Station 1292–1368+66.	J. B. Lewis	57,620	8,643.00	R 495
93.....	Below Lakeport, Station 40–105.	Ernest Hyner	146,314	26,248.73	R 496
93.....	Adams Front, Station 106–306.	Kilpatrick & Storer	282,694	40,962.35	R 498
93.....	Kigers Loop, Section 1..	Jas. S. Peak.....	55,892	6,707.04	R 504.5
93.....	Kigers Loop, Section 2..	Timothy Sullivan	67,768	9,406.20	R 505
93.....	Kigers Loop, Section 3..	.....do	59,229	8,286.13	R 505.5
93.....	Sans Field.....	W. A. Shippey.....	139,924	19,575.37	R 425
93.....	Mathews Bend.....	C. H. Dulaney	100,916	13,119.08	R 508
93.....	Leland Spur.....	Hugh McCarten	14,709	1,470.90	R 468
93.....	Mathews Bend Banquette.	L. C. Dulaney	24,524	2,881.57	R 508
93.....	Luna Levee.....	Sullivan & Lewis.....	.....	*5,311.36	R 468
	Expended high-water protection, repairs, and engineering expenses to May 31, 1894.	.....	.....	67,609.63	
	Total cubic yards to May 31, 1894.	.....	5,769,674.2	.....	
	Total cost to May 31, 1894.	.....	.....	1,419,009.70	

* Retained per cent not paid last report.

Cost of levees in the third district, built and enlarged by the United States, from 1882 to May 31, 1894.

LOUISIANA.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch-to-mile map.
1882–1893...	Levee construction	....	2,454,774	$528.722.86	
1882–1893...	High-water protection, repairs, and engineering expenses.	....	.....	133,207.92	
1893.....	Villa Vista, upper section ..	M. V. Henry.....	129,086.7	19,272.63	R 573
1893.....	Villa Vista, middle section..	Jno. Scott & Son.....	135,652.2	25,027.80	R 574
1893.....	Villa Vista, lower section...	W. L. Withers & Co ..	166,732.2	28,344.47	R 575
1893.....	Salem, upper section.....	Manning & Gibson....	97,720	15,635.20	R 565
1893.....	Salem, lower section.....	.....do	144,443.2	20,929.81	R 566
	High-water protection, repairs, and engineering expenses to May 31, 1894.	....	.....	11,962.87	
	Total cubic yards to May 31, 1894.	.....	3,128,408.3	.....	
	Total cost to May 31, 1894.	.....	.....	783,103.58	

List of civilian engineers employed on work of river and harbor improvement, in charge of Capt. C. McD. Townsend, Corps of Engineers, from May 31, 1893, to May 31, 1894, inclusive, under the river and harbor acts approved August 11, 1888, September 19, 1890, March 3, 1891, July 13, 1892, and sundry civil act March 3, 1893.

Name and residence.	Time employed, months.	Compensation per month.	Where employed.	Work on which employed.
Arthur Hider, Greenville, Miss.	12	$250.00	Greenville, Miss	Care and repairs to plant; repairs to revetment Louisiana Bend, Bolivar, Miss., and Delta Point, La.
E. C. Tollinger, Greenville, Miss.	12	175.00	.....do	Construction and repair of levees in Mississippi south of Greenville and in Arkansas south of Greenville to Louisiana line.
H. St. L. Coppée, Vicksburg, Miss.	12	175.00	Vicksburg, Miss., Arkansas City, Ark.	Surveys at Greenville and Delta Point; construction and repair of levees in Arkansas north of Greenville.
John J. Hoopes, Arkansas City, Ark.	12	150.00	Arkansas City, Red Fork, Ark.	Construction and repair of levees in Arkansas.
J. D. Van Meter, Rosedale, Miss.	12	150.00	Rosedale, Miss.	Construction and repair of levees in Mississippi north of Greenville.
W. S. Brown, Lake Providence, La.	12	150.00	Lake Providence, La .	Construction and repair of levees in Louisiana, Third District.

Approximate value of plant belonging to the United States and used upon the third district, Mississippi River, May 31, 1894.

Class of property.	Pieces.	Approximate value.	Class of property	Pieces.	Approximate value.
Steamer Etheridge	1	$8,000	Dump scows	2	$5,000
Steamer Osceola	1	6,000	Calking flats	9	1,[illegible]
Steamer Vidalia	1	5,000	Machine shop with outfit	1	2,500
Steamer Vedette	1	3,500	Floating dock	1	15,000
Steamer Meter	1	2,500	Camel docks	3	1,[illegible]
Tug Parker	1	3,500	Pile-drivers and machinery	6	4,5[illegible]
Mattress boats	6	6,000	Yawls	7	10[illegible]
Headquarter boat	1	1,200	Skiffs	55	500
Quarter boats with outfit	14	10,200	Dredge Menge	1	10,000
Store and shop boats	2	1,500	Tools and appliances	.....	800
Hydraulic graders	2	12,000	Office furniture, safe, etc	.....	250
Hydraulic graders (small)	1	500	Surveying instruments	.....	2,000
Barges, model	10	10,000			
Barges, square	80	90,000	Total value	.....	202,150
Barges, fuel	3	2,400			

Financial statement.

LAKE PROVIDENCE REACH.

Balance May 31, 1893	$24,725.03	
Allotted during current fiscal year	10,000.00	
		$34,725.03
Expended to May 31, 1894		28,170.94
Balance May 31, 1894		6,554.09
In hand		6,554.09
Less amount covered by existing contracts and liabilities		931.33
Available balance May 31, 1894		5,622.76
Expenditures apportioned:		
Labor on construction		2,074.02
Material for construction		8,534.18
Subsistence		4,108.91
Cost of plant, repairs, and outfit		3,846.80

nditures apportioned:		
are of public property		$556.17
owage and steamer expenses		5,135.65
dministration and office expenses		3,427.54
ledicine and medical attendance		316.67
liscellaneous		171.00
Total		28,170.94
unt that can be profitably expended during fiscal year ending June 1896		300,000.00

VICKSBURG, MISS.

ace May 31, 1893		$6,039.62
nditures to May 31, 1894		5,931.55
Balance May 31, 1894		108.07
und		108.07
amount covered by existing contracts and liabilities		108.07
nditures apportioned:		
Labor on construction		2,604.26
Material for construction		1,012.74
Subsistence		247.33
Cost of plant, repairs, and outfit		87.67
Care of public property		110.83
Towage and steamer expenses		1,600.22
Administration and office expenses		210.17
Medicine and medical attendance		58.33
Total		5,931.55

LAKE BOLIVAR FRONT.

nce May 31, 1893	$2,622.80	
tted during current fiscal year	15,000.00	
		$17,622.88
ended to May 31, 1894		17,518.42
Balance May 31, 1894		104.38
and		104.38
ount covered by existing contracts and liabilities		104.38
enditures apportioned:		
Labor on construction		4,511.08
Material for construction		5,674.39
Cost of plant, outfit, and supplies		462.03
Care of public property		458.84
Towage and steamer expenses		3,300.38
Administration and office expenses		719.93
Subsistence		2,098.47
Medicine and medical attendance		293.30
Total		17,518.42

PLANT THIRD DISTRICT.

Balance May 31, 1893	$5,681.71
Expended to May 31, 1894	5,681.71
penditures apportioned:	
Labor on repairs	735.25
Material for construction	2,376.54
Cost of plant, outfit, and supplies	1,402.53
Care of plant	979.50
Subsistence	123.33
Miscellaneous	61.56
Total	5,681.71

PLANT.

Allotted during current fiscal year	$113,000.0
Expended to May 31, 1894	82,640.9
Balance May 31, 1894	30,359.0
In Treasury	40,000.0
Less amount overdrawn	9,640.9
	30,359.0
Less amount covered by existing contracts and liabilities	26,200.0
Available balance May 31, 1894	4,159.0
Expenditures apportioned:	
Labor on repairs	16,949.5
Material for repairs	12,060.6
Cost of plant, supplies, and outfit	27,065.7
Care of public property	10,459.0
Administration and office expenses	5,826.6
Medicine and medical attendance	519.1
Subsistence	9,430.2
Miscellaneous	309.9
Total	82,640.9
Amount that can be profitably expended during the fiscal year ending June 30, 1896	60,000.0

SURVEYS, GAUGES, AND OBSERVATIONS.

Balance May 31, 1893	$298.42	
Allotted during current fiscal year	12,000.00	
		$12,298.42
Expended to May 31, 1894		7,007.59
Balance May 31, 1894		5,290.83
In Treasury		5,000.00
In hand		290.83
		5,290.83
Less liabilities		800.00
Available balance May 31, 1894		4,490.83
Expenditures apportioned:		
Surveys		4,914.83
Steamer expenses		1,256.19
Outfit, material, and stationery		341.11
Subsistence		435.76
Miscellaneous		59.70
Total		7,007.59
Amount that can be profitably expended during fiscal year ending June 30, 1896		12,000.00

LOWER YAZOO LEVEE DISTRICT.

Balance May 31, 1893	$24,918.98	
Allotted during current fiscal year	150,000.00	
		$174,918.98
Expended to May 31, 1894		162,134.21
Balance May 31, 1894		12,784.77
In hand		12,784.77
Less liabilities		600.00
Available balance May 31, 1894		12,184.77

nditures apportioned:		
evee construction and repairs		$142,205.51
ngineering and office expenses		15,290.69
igh-water protection		4,638.01
Total		162,134.21
nt that can be profitably expended during fiscal year ending June 896		300,000.00

UPPER TENSAS LEVEE DISTRICT.

ce May 31, 1893		$27,479.32
ed during current fiscal year		300,000.00
		327,479.32
ferred to Middle Tensas Levee District	$5,000.00	
ided during current fiscal year	309,302.00	
		314,302.00
Balance May 3, 1894		13,177.32
easury		10,000.00
nd		3,177.32
		13,177.32
liabilities		1,000.00
Available balance May 31, 1894		12,177.32
nditures:		
evee construction and repairs		263,958.98
ngineering and office expenses		21,787.28
ligh-water protection		23,555.74
Total		309,302.00
unt that can be profitably expended during fiscal year ending June 1896		300,000.00

MIDDLE TENSAS LEVEE DISTRICT.

nce May 31, 1893	$17,341.19	
tted during current fiscal year	100,000.00	
ransfer from Upper Tensas Levee District	5,000.00	
		$122,341.19
ended to May 31, 1894		121,172.78
Balance May 31, 1894		1,168.41
and		1,168.41
liabilities		600.00
Available balance May 31, 1894		568.41
enditures apportioned:		
Levee construction and repairs		109,209.91
Engineering and office expenses		7,550.07
High-water protection		4,412.80
Total		121,172.78
unt that can be profitably expended during fiscal year ending June 0, 1896		300,000.00

IMPROVING HARBOR AT VICKSBURG, MISS.

ance May 31, 1893	$55,812.26
ended to May 31, 1894	44,758.52
Balance in hand May 31, 1894	11,053.74

vailable balance as above.

Expenditures apportioned:	
Dredging	$27,501.7
Labor on construction	4,369.3
Material for construction	4,487.5
Subsistence	2,164.0
Cost of plant, repairs, and outfit	12.4
Care of public property	1,139.1
Towage and steamer expenses	2,079.3
Administration and office expenses	2,183.1
Medicine and medical attendance	250.0
Miscellaneous	571.6
Total	44,758.5
Amount that be profitably expended during fiscal year ending June 30, 1896 (for Delta Point)	200,000.0

IMPROVING HARBOR AT GREENVILLE, MISS.

Balance May 31, 1893	$5,241.5
Expended to May 31, 1894	2,991.8
Balance May 31, 1894	2,249.6
In hand	2,249.6
Less amount covered by existing contracts and liabilities	876.1
Available balance May 31, 1894	1,373.5
Expenditures apportioned:	
Labor on construction	1,049.8
Material for construction	685.1
Care of public property	27.0
Towage and steamer expenses	1,014.5
Subsistence	143.5
Miscellaneous	71.5
Total	2,991.8
Amount that can be profitably expended during fiscal year ending June 30, 1896	100,000.0

STONE.

Allotted during current fiscal year	$100,000.0
Expended to May 31, 1894	42,824.1
Balance May 31, 1894	57,175.8
In Treasury	80,000.0
Less amount overdrawn	22,824.1
	57,175.8
Less amount covered by existing contracts	57,175.8
Expenditures apportioned:	
Stone	15,902.9
Towing and steamer expenses	16,846.9
Cost of plant, outfit, and repairs	4,834.7
Care of public property	566.5
Administration and office expenses	1,522.6
Subsistence	3,007.3
Miscellaneous	143.0
Total	42,824.1

tract of proposals for levee work in Middle Tensas levee district for the fiscal year ding June 30, 1895, received and opened by Capt. C. McD. Townsend, Corps of Engi- ers, December 19, 1893.

Name of bidder.	Reid levee.	
	Upper section.	Lower section.
	Cents.	*Cents.*
Jeffries & Dameron	27	24½
John G. Sessions	.....	22.22
Timothy Sullivan	31	18½
Isaac Henry	28.73	28.73
McLaughlin Bros	18¾	16.73
L. C. Dulaney	22	14
J. B. Lewis	26	25
Edward C. Manning	34	28
John Scott & Son	23½	23½
Ernest Hyner	20½	19½
Sterling Fort	24.99	.....
L. Aschaffenberg	21.47	19.23
Robert Johnson	17.74	16.49
J. S. McTighe & Co	20.4	20.4
W. L. Withers & Co	23½	21¾
McGuire & O'Donnell	19¾	.....
Arnold & De Garis	19⅝	18⅝
Homan & McFadden	18.9	17.4
J. S. Hodge	17½	15¾
Eltringhaus Construction Co	.....	19.4
W. J. Bentley & Co	26¾	25½
Robert Nicholson	16.21	.....

tract of proposals for levee work in Upper Tensas levee district (Red Fork), received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 12, 1894.

Name of bidder.	Section 1, station 0 to 50.	Section 2, station 50 to 90.	Section 3, station 90 to 140.	Section 4, station 140 to 190.	Section 5, station 190 to 240.	Section 6, station 240 to 290.	Section 7, station 290 to 340.	Section 8, station 340 to 390.	Section 9, station 390 to 477.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
J. S. McTighe & Co	.....	10	9½	9½	10	10½	12½	14	11½
Manning & Gibson	7¾	7¾	7¾	7¾	9½	11	12⅜	16½	14⅜
Jeffries & Dameron	11	11	10	9¾	10	11	12⅜	15½	14
Jennings & Co	10½	10½	10½	11	11	11	12.40	14.70	11.98
James H. Cary	8½	10	10	8½	.....	.....	.....	.....	.....
Terrell & Watkins	9.73	9	8.20	9.20	.....	.....	.....	.....	.....
The Whitehill Co	9½	10	9½	9½	9¾	9.99	9¾	10½	9
John Scott & Son	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94
C. A. Winter	10⅜	11⅞	9.98	9.98	9.98	10⅛	14½	16⅛	13⅞
J. B. Lewis & Co	8.95	9.24	8.94	8.94	9.49	9.48	10.44	11.99	9.94
L. C. Dulaney	20	20	20	19	19	19	19	19	19

ections 1 to 4 inclusive to be paid for from allotment for fiscal year ending June 30, 1895.
ections 5 to 9 inclusive to be paid for from allotment for fiscal year ending June 30, 1896.

tract of proposals for levee work in Lower Yazoo levee district, opened by Capt. C. McD. Townsend, Corps of Engineers, April 26, 1894, under allotment for fiscal year end- ng June 30, 1895.

Name of bidder.	Below Australia.		Buck-ridge.	Chotard to Brunswick.	
	Station 0 to 53.	Station 53 to 124.		Upper section.	Lower section.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Robert Johnson	10.99	10.74	11	14¼	14⅛
J. E. Moon	14.20	13.90	15.90	.....	.....
John Scott & Son	10.45	10.45	12.45	12.45	16.45
Eltringhaus Construction Co	16½	16	16	14	18
Davis & Wood	.....	.....	.....	21	17½
McGuire & O'Donnell	.....	.....	.....	14¼	25
Johnson & Crowe	.....	.....	.....	16⅜	17½
John G. Sessions	12.9	11.9	14½	15½	15.97
John A. Carson	16	16	16	22	24

Expenditures apportioned:
Dredging .....
Labor on construction.....
Material for construction.....
Subsistence .....
Cost of plant, repairs, and ou
Care of public property ...
Towage and steamer exper
Administration and office
Medicine and medical at
Miscellaneous.....

Total .....
Amount that be profita
1896 (for Delta Poin

for the fiscal year ending Jun nd, Corps of Engineers, D

unther Forest.

Station 7 to 54

Balance May 31,
Expended to M

Balance

In hand .
Less amo

Av

Exp

	9.99	8.97							
	11¾		12.9			24¾	13		
	10.45	10.24	12.24	33	31	14.94	12.48	10	
	12.22	12.22	15.94					9.96	
	11.74	11.74	12.94	39	33½	13½	10.98	15	15½
				27½	25	13	14	10.21	
	12	9.90	12⅝				14¾		
	10.98	9	11.44			14.98	12.43	15.49	18
				29.97	23.99				
	11¾	10.40							
								10¾	13½
	9.85	8.74	11⅛			14¼		11.85	13
	20.4	20.4	20.4	20.4	20.4	20.4	10.98	20.4	20.4
				19¾	17.85		14		
	10	9½	11			11½	10.21		
	11⅞	10½	11⅞	27⅜	25⅜	14⅞	14¾	10⅜	14½
						14⅜		13⅜	14.7
	10.73	10½	14⅜	34	28	14⅜	12.43	12.38	19½
							13	13	14½
	12⅜	11⅜	13⅜	25⅜	23⅜	13	14¾	12.98	14
	13.2	12.3	12.7			24.4	15.4		
				27	25	16	12.43	16	18
				25	23	13	22	14½	16½
								11.99	
	12½	11	11.30						
	12½	11¾	13					17	19½

Abstract of proposals for levee work in Upper Tensas levee district for the fiscal year ending June 30, 1896, received and opened by Capt. C. McD. Townsend, Corps of Engineers, December 19, 1893.

No.	Name of bidder.	Opossum Fork.*	Mathews Bend.†				
		Stations 317 to 335.	Stations 0 to 30.	Stations 30 to 73.	Stations 73 to 115.	Stations 115 to 162.	Stations 641 to 72
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents*
1	P. F. Lamb				15½		17
2	Jeffries & Dameron	25	25	21	15	18½	18
3	John G. Sessions		18.94	18	12.48	16.74	12.48
4	Timothy Sullivan	19¾	18½	10.95	10.95	12¾	19
8	McLaughlin Bros	27					
10	L. C. Dulaney	20	18	14	12½	12½	12
11	J. B. Lewis	19¾	19¾	19½	15	17	16
12	James Kennedy	16					
14	C. A. Winter	23		23	15	19	
16	T. S. Aderholdt	17					
17	Edward C. Manning				14.93		
19	Ernest Hyner		19.9	18	16	16	16
24	L. Aschaffenberg		37¼	22	14¾	18½	13½
27	J. S. McTighe & Co	20.4	20.4	20.4	20.4	20.4	20.4
29	The Whitehill Co	17½					
30	John W. Cannon		24	24	16⅝	17⅞	14
32	W. L. Withers & Co				17½	22½	
34	Arnold & DeGaris	25⅜	17⅜	17⅜	15⅜	16⅜	17
36	W. R. Harvey		24	23	16	17	17
37	J. C. Hodge		18	16½	15½	19	15
38	James S. Peak				18		17
40	W. J. Bentley & Co		19	19	17½	18½	17

* Cypress Creek line. † All bids on Mathews Bend levee rejected.

MISSISSIPPI RIVER COMMISSION 2966 REPORT OF

...sals for levee work ...895, received and ... 1893.

...per Tensas levee district, under allotment for ...d opened by Capt. C. McD. Townsend, Corps

No.	Name	Sain's plantation on the Cypress Creek line.	Mathews Bend.
		Cents.	*Cents.*
		16½	18.97
		15½	14⅞
			18½
		15	
		15	25
		15⅝	18⅝
		18	23
		18	22
	C. Manning	15	27
	Scott & Son	14.49	19.49
	arnest Hyner	13.99	
	Sterling Fort		18½
	L. Aschaffenberg	19⅝	21½
	Robert Johnson	16½	
	J. S. McTighe & Co	15½	15.48
	W. L. Withers & Co	19	21.95
	McGuire & O'Donnell	4.46	17.89
	Arnold & De Garis	45	22.24
	Homan & McFadden	19⅛	24½
	J. S. Hodge	18.9	13
	Eltringhans Construction Co	17⅛	20
	W. J. Bentley & Co		
	Robert Nicholson	26⅜	
		16.21	

Abstract of proposals for levee work in Upper Tensas levee district (Red Fork), received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 12, 1894.

No.	Name of bidder.	Section 1, station 0 to 50.	Section 2, station 50 to 90.	Section 3, station 90 to 140.	Section 4, station 140 to 190.	Section 5, station 190 to 240.	Section 6, station 240 to 290.	Section 7, station 290 to 340.	Section 8, station 340 to 390.	Section 9, station 390 to 477.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	J. S. McTighe & Co		10	9⅛	9⅛	10	10⅛	12⅛	14	11⅛
2	Manning & Gibson	7⅛	7⅛	7⅛	7⅛	9⅛	11	12⅛	16⅛	14⅞
3	Jeffries & Dameron	11	11	10	9⅞	10	11	12⅛	15⅞	14
4	Jennings & Co	10⅛	10⅛	10⅛	11	11	11	12.40	14.70	11.98
5	James H. Cary	8⅛	10	10	8⅛					
6	Terrell & Watkins	9.73	9	8.20	9.20					
7	The Whitehill Co	9⅛	10	9⅛	9⅛	9⅛	9.99	9⅛	10⅛	9
8	John Scott & Son	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94
9	C. A. Winter	10⅜	11⅞	9.98	9.98	9.98	10⅛	14⅛	16⅝	13⅞
10	J. B. Lewis & Co	8.95	9.24	8.94	8.94	9.49	9.48	10.44	11.99	9.94
11	L. C. Dulaney	20	20	20	19	19	19	19	19	19

Sections 1 to 4 inclusive to be paid for from allotment for fiscal year ending June 30, 1895.
Sections 5 to 9 inclusive to be paid for from allotment for fiscal year ending June 30, 1896.

Abstract of proposals for levee work in Lower Yazoo levee district, opened by Capt. C. McD. Townsend, Corps of Engineers, April 26, 1894, under allotment for fiscal year ending June 30, 1895.

No.	Name of bidder.	Below Australia.		Buckridge.	Chotard to Brunswick.	
		Station 0 to 53.	Station 53 to 124.		Upper section.	Lower section.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Robert Johnson	10.99	10.74	11	14¼	14½
2	J. E. Moon	14.20	13.90	15.90		
3	John Scott & Son	10.45	10.45	12.45	12.45	16.45
4	Eltringhaus Construction Co	16½	16	16	14	18
5	Davis & Wood				21	17½
6	McGuire & O'Donnell				14⅞	25
7	Johnson & Crowe				16⅝	17½
8	John G. Sessions	12.9	11.9	14¼	15¼	15.97
9	John A. Carson	16	16	16	22	24

as a straight line, shown as a full line on the accompanying blue print, the Helena reading exceeding the Cairo reading between 10 feet and the overflow stage.

Similar discrepancies between individual observations and this mean are observed as were found by Col. Suter, and called by him "a change of plane," in a paper which is printed in the report of the Mississippi River Commission for 1891.

To investigate further this change of plane I have compared the crests of rises passing Cairo within 1 foot of readings on the gauge of 15, 20, 25, 30, and 35 feet. These readings are appended. The same tendency to a permanent lowering of the plane since 1884 which was observed in low-water stages is found throughout these tables. On the blue print the broken and dotted line represents approximately the mean gauge relations prior to 1884; the broken line, the relations subsequent to that date. (The means of the limited number of readings in these tables are shown by crosses and circles.) Other discrepancies can be observed, however, in these tables, which can not be accounted for by this theory.

The record of the gauge at Wittsburg, on the St. Francis River, has been reported since 1884. The reading of this gauge on the day preceding the passage of the crest of the rise by Helena is given in the tables. An examination of these records shows that little or no relation exists between the height of the St. Francis River and this change of plane at Helena while the Mississippi River is at low or medium stages. If, however, the observations be plotted, using for abscissæ the rate of rise at Cairo for five days preceding the observation, and for ordinates the difference between the readings of the Helena and Cairo gauges, it will be noted that when there is a rapid rise at Cairo there is a tendency to a lower reading of the Helena gauge than when the rise at Cairo is slow; i. e., a cause of change of plane at Helena has been the rate of rise of the main river and consequent change of slope.

The exceptions to this rule, which are numerous, can all be accounted for by the condition of the bed of the river. The readings at Helena during the latter part of the year 1889 are abnormally low. The flood of 1889 was also exceptional, the water not rising above bank-full stage. I account for the discrepant readings of that year from the fact that the high water had not sufficient force to fill up with sand the channels across bars which the preceding low water had scoured out. As the water fell it found a deeper channel than usual in which it was working, and could therefore cut out the bars more than normally. The same is shown in the year 1885, another low-flood year.

It is also noted that if the rise occurs on a river which is falling to its low-water stage, the height attained by the Helena gauge is greater than if the rise occurs after the river has attained that stage, a phenomenon similar to that observed in successive low waters of the same year; from which I deduce that the condition of the bars as well as the rate of rise of the river is a cause of the change of plane noted at Helena.

It would require a third differentiation to determine the influence of the St. Francis River upon the Helena gauge, for which purpose there are not enough observations; but they are sufficient to show that at low and medium stages of the Mississippi River the influence of the St. Francis River upon it is slight. I also find that the crest of the rise is transmitted to Helena with great regularity, the period between the two gauges being generally four days. If the St. Francis was exerting much influence, this period would be more irregular. There is, however, a tendency of low readings which are not in conformity with the rate of rise at Cairo to occur one day earlier than normal readings.

Above the overflow stage, however, the conditions noted below that stage do not exist. The reading of the Helena gauge appears to be more dependent on the reading of the Wittsburg gauge than on the rate of rise at Cairo. The change of plane at lower stages has been eliminated. The floods of 1886, 1890, and 1893, when compared with those of 1882, 1883, and 1884, would indicate that since 1885 there has been a rise of the flood plane at Helena of about 1 foot.

On the blue print are platted the different maximum gauge readings which have been observed at overflow stages since 1872; the line shown thereon above the 40-foot stage is the limiting line of gauge relations to which the Helena gauge will rise for a given flood height at Cairo, which fills the basin. The lesser heights which are found by observation are attributed to the fact that the flood has not been of sufficient duration to allow the inflow into the basin to produce its full effect upon the Helena discharge. During the twenty years the observations have been recorded there has been no combination of conditions which has raised the Helena gauge above that line; the return of the flood wave from the St. Francis River has in that time never produced an "engorgement" greater than it represents.

The abrupt break in the line of gauge relations at the overflow stage is to be noted. I consider it a logical assumption that the protection of the St. Francis Basin will cause a junction of these lines, and that the curve above the overflow stage will be straightened.

With a rapid completion of the levee system of the St. Francis Basin it is deemed

obable that the broken line extended would represent the mean gauge relations ich would exist between Cairo and Helena, with a possible reappearance of the hange of plane" above the overflow stage. Should this relation exist, there will an increase in extreme flood heights at Helena of over 4 feet.

It is also considered probable that if the work is gradually done there may be a rther lowering of this plane, due to a further scouring out of the low-water chan-l, but the fact that the lowering of the low-water plane is not yet observable at e mouth of the White River nor at Lake Providence would indicate that this ocess is slow, though it is to be noted in this connection that at Lake Providence recent years there appears to be a widening of the river, which increases its dis-arge capacity at high stages.

When the crests of these rises pass the mouth of White River and Vicksburg, the me tendency to a raising of the plane of gauge relations in recent years is noted at e mouth of White River, as was seen in extreme low stages. At Vicksburg these the same marked lowering of the plane. The same abnormally low readings are so to be observed at Vicksburg in the latter part of the years 1885 and 1889 that ere found at Helena, though they are not apparent at the mouth of White River.

When the gauges at Little Rock, on the Arkansas River, and Jacksonport, on the hite River, are examined, there is found to be a relation between those gauges nd the variations in the height of the crest of the wave at the mouth of White iver. These rivers pour out sufficient water to affect materially the flow of the lissisippi. The rate of rise of the main river, or the condition of the bottom, are ss important factors in determining the height than the flow of the tributary.

Increased heights of from 7 to 3 feet are clearly attributable to a large flow, par-cularly from the Arkansas River. When these observations are eliminated from ie tables there is still noted a tendency to a raising of the plane of gauge relations t the mouth of White River. As this change of plane is affected not only by the auge heights found in the different rivers, but by their rates of rise or fall, too any elements are introduced for discussion with the data available. It is sufficient or the purposes of this paper to note that for a 35-foot stage at Cairo such a combi-ation of conditions can arise as to produce an overflow stage at the mouth of White iver.

In 1887 Capt. W. T. Rossell, Corps of Engineers, U. S. Army, submitted an esti-ate to the Commission of the heights which would be attained by floods through he third district after the levees had been completed in the Tensas Basin, based pon the theory that the relation that exists between gauges below the overflow stage ould exist above it when the levees were completed. The following are the results educed by him, and the heights that occurred in 1893:

Locality.	Capt. Rossell's estimated heights.	1893 heights.	Difference.
	Feet.	*Feet.*	*Feet.*
Cairo	52.17	40.3	—2.8
Helena	48.10	47.9	—.2
Arkansas City	49.60	50.30	+.7
Greenville	45.30	44.30	-1
Lake Providence	43.60	41.35	—1.75
Vicksburg	48.60	48.30	—.3

A similar method of reasoning would give an increased height to floods at Helena of over 5 feet, due to the protection of the St. Francis Basin, i. e., it would be the prolongation of the full line of the blue print to 52 feet on the Cairo gauge.

If it had not been for the crevasses in 1893 Capt. Rossell's estimated heights would have been generally exceeded in the third district from the mouth of White River to Vicksburg. The increased discharges we are having from the White and Arkansas rivers in recent years are more than compensating for any increase in discharge section, which may be due to the construction of levees on the Mississippi. Notwithstanding the fact that at Vicksburg there has been a marked lowering of the plane of gauge relations from low water to the overflow stage, the extreme flood heights of 1892 and 1893 closely approach that of 1882; that of 1890 exceeds it.

These observations have practical application in the problem of protecting the St. Francis Basin.

During the floods of 1892 and 1893 there has poured across the Tensas Basin an amount of water equal to the combined flood discharges of the White and Arkansas rivers. I estimate that when the levees are completed, which are to be constructed in the Tensas Basin and along the Arkansas River, from the allotments for the fiscal years ending June 30, 1895, and June 30, 1896, there will be added to the flood discharge in the river at Lake Providence at least 30 per cent more water than now

passes that point. Such an increase will strain existing levees to their
ity, and if with it added heights are propagated from Helena, disa
to both the Yazoo and Tensas basins. To increase the height of leve
necessitate an addition of nearly 20,000,000 cubic yards of earth to the
of the Lower Yazoo levee district, more earth than its people have b
in twenty years.

It is a question for serious consideration whether the extension of the l
to other basins than those now protected should not be deferred until
have produced their maximum effect in enlarging the discharge sectio

It has been recently stated,* in advocacy of the theory that the p
basin will reduce flood heights below it, that there is a loss of energy
overflow into a basin. "When the latter is returned it is poured int
sippi with a sluggish velocity and at an unfavorable angle, so that it
upon the latter, which has all it can do to transport its own mass agai
ance of friction. Therefore an engorgement must ensue until the
acquire head enough to confer the requisite velocity."

This would imply that the discharge of a tributary stream will cau
tion of velocity in the main river below the junction.

The laws governing the flow of a column of water are immutable, w
water flows in a river, a pipe, or a pump. The force which generates
pressure applied at one end of the column, which is opposed by a pre
other end. The difference between these pressures, "head," is resisted
tion of the column against the inclosing material and by its inertia. An
the head or a diminution of friction increases velocities. If a pipe und
is tapped it will be admitted that but little water will be introduced int
ing unless a greater exterior pressure is applied than exists in the pipe.

The same principle applies to the Mississippi River. If its waters ha
head than exists in a tributary they will flow into the tributary until
has acquired an equal head. It is a universal law that force will te
motion from a higher to a lower potential. This action is frequently vi
mouths of the White and Arkansas rivers, whose waters differ in color f
the Mississippi. The "engorgement," the formation of the bank of s
place in the tributary, not in the main stream.

When the tributary has acquired sufficient head it begins to discharg
rate of discharge is a factor of difference in pressures, but whatever wat
to the river increases its height, increases the difference in pressures that
on the filaments of water that are formed below the junction, and acce.er
ties. It is the tributary that has done the climbing; nor does the fac
highest gauge reading at the foot of a basin is found when the return wav
tributary flows into the river vitiate the argument.

If the St. Francis Basin was of unlimited capacity, the floods at Hel
exceed the overflow stage but little, no matter what height was attained b
of the wave at Cairo. The St. Lawrence is a river which has such a basi
capacity of the St. Francis is limited. After a time the water that has c
acts like a levee in restraining more water in the river channel, and the flo
rises, and no matter how much energy is lost through the forests and under
St. Francis River still retains sufficient force to climb on top of the flood
passes its mouth.

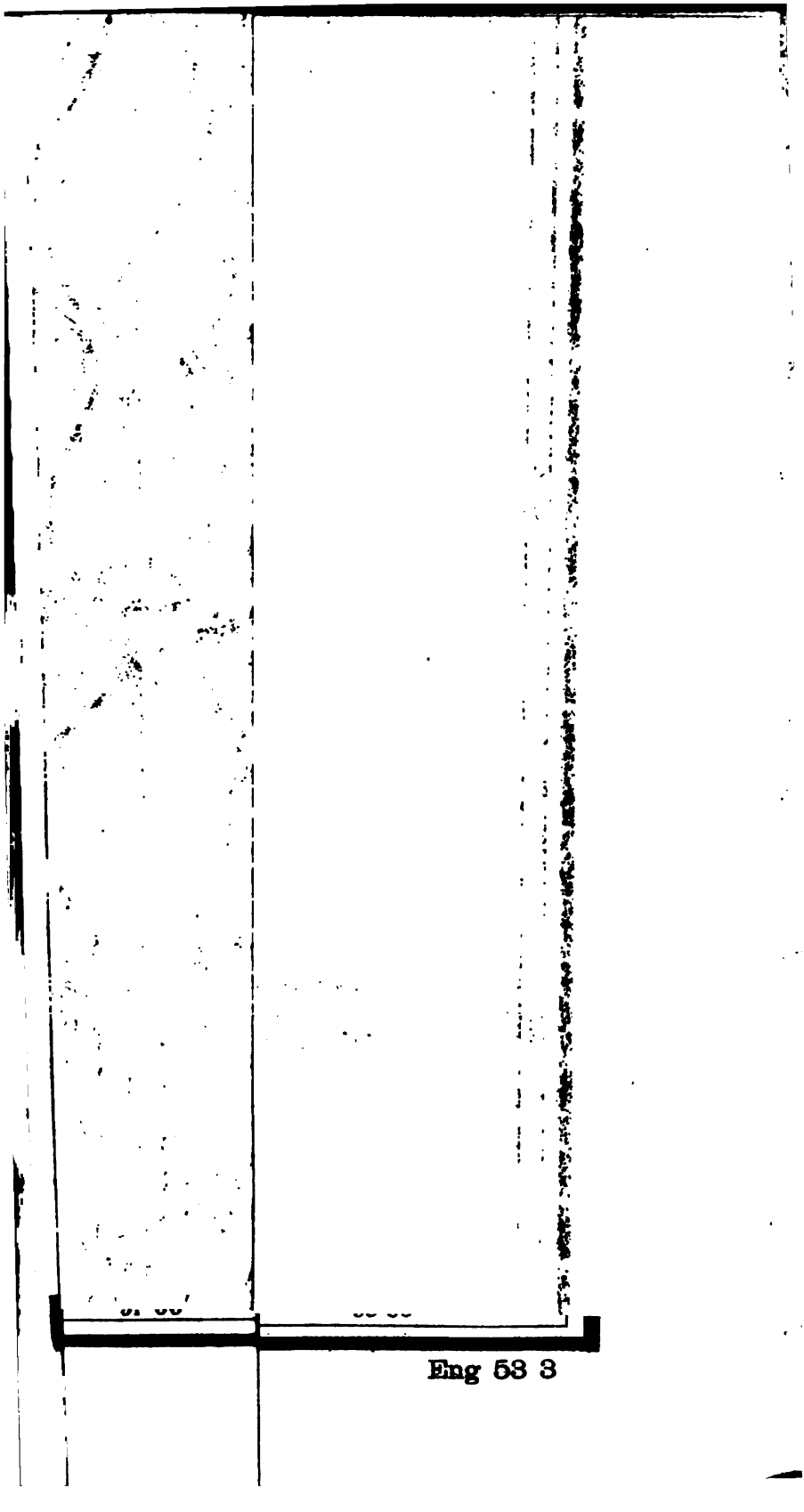
I am of the opinion that the difference in gauge readings at Cairo and H
fair measure of the loss of energy between the points. If there was re
much energy in the water at Helena as existed at Cairo the river would
high a stage. Below the overflow stage the energy in the stream raises t
gauge to a higher reading than that at Cairo.

These basins are nothing but lakes or reservoirs, which absorb energ
stages of the inflowing streams, gradually returning it to the outflow.
energy that can be absorbed by the undergrowth of the St. Francis the be
be for the lower basins.

The fact that flood heights have not increased at Vicksburg with the
tion of the levees in the Yazoo basin is usually quoted in advocacy of th
The cut-off that occurred at Delta Point in 1876 and the subsequent sho
the river in the vicinity makes this gauge exceptional. There is a lower
Vicksburg gauge for all readings below the overflow stage.

The only fair comparison is the flood of 1890, when there were numerou
in Mississippi, and 1892, when there were none. The flood of 1890 was six
a foot higher than that of 1892. But this does not prove that the lowering effe
due to the Mississippi levees. The floods of 1890 and 1892 had about the same max
imum discharge at the latitude of Lake Providence, but the amount of water tha

* Starling on Floods of the Mississippi River with Reference to the Inundation o
the Alluvial Valley, p. 10.



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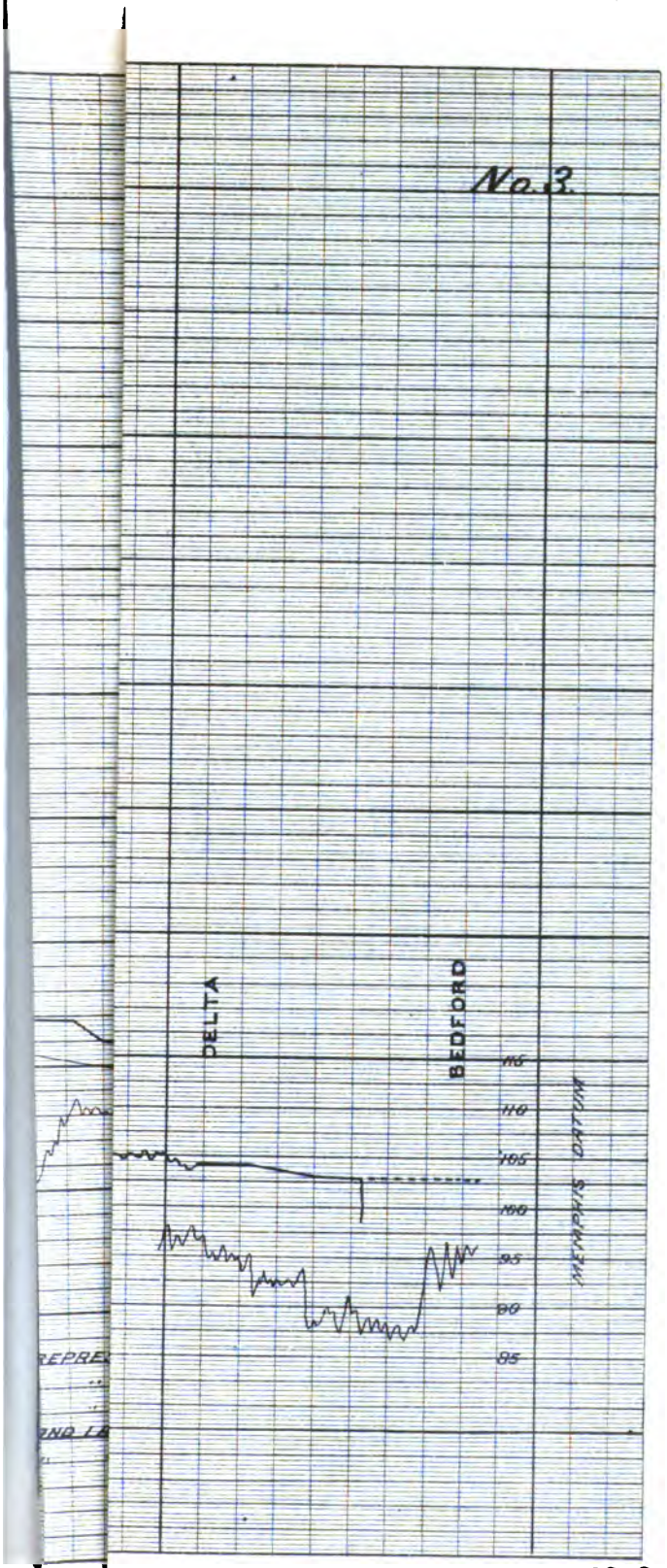

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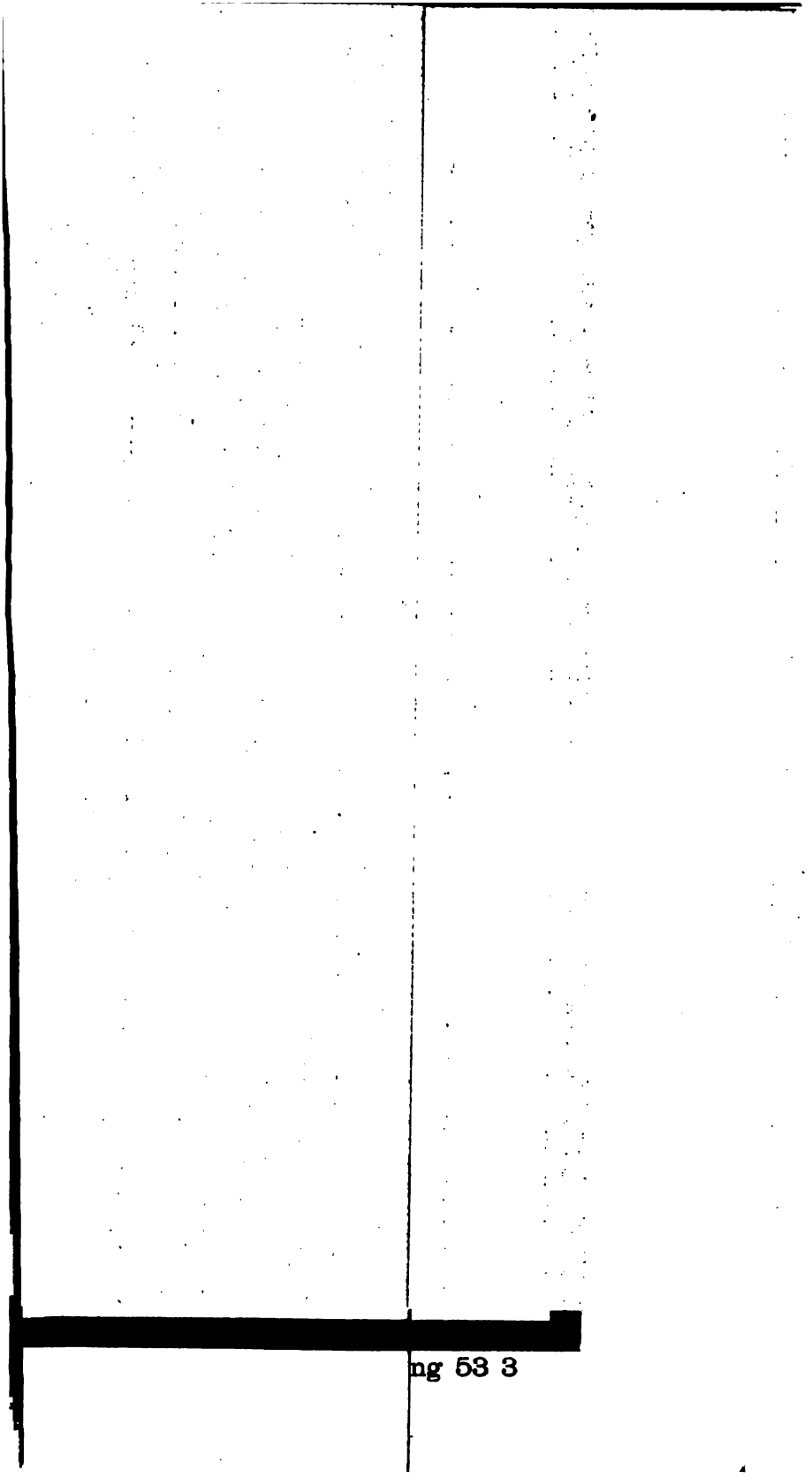

ng 53 3

ɔed into the Tensas Basin in 1892 and did not pass Vicksburg largely exceeded in 1890.

is the failure of the Arkansas levees that has affected the Vicksburg gauge, not olding of those in the Yazoo Basin.

ere is, however, a case of engorgement from tributaries that is only too frequent ugh the Third District. When floods from the White, Arkansas, and Red rivers ede those of the Mississippi they fill up the river channel sometimes to the over- stage. When a flood from the upper rivers is precipitated on this condition of rs an increased pressure has already been applied at the lower end of the col- , velocities are diminished, and flood heights raised.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain of Engineers.

ɔn. C. B. COMSTOCK,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

TABLE NO. 1.—*Low water, 1872 to 1892.*

te of low ater at Cairo.	Cairo.	Helena.	Difference.	White River.	Difference, White River and Cairo.	Difference, White River and Helena.	Lake Providence.	Difference, Lake Providence and Cairo.	Difference, Lake Providence and White River.	Vicksburg.	Difference, Vicksburg and Cairo.	Difference, Vicksburg and Lake Providence.
ɹt. 25, 1872	4.53	6.00	+1.47	4.20	—0.33	—1.80	2.83	—1.70	—1.37	5.41	+0.88	+2.58
v. 3, 1872	2.20	3.00	+0.80	1.42	—0.78	—1.58	—0.80	—3.00	—2.22	1.81	—0.39	+2.61
c. 9, 1872	1.12	1.50	+0.38	0.74	—0.38	—0.76	—2.55	—3.67	—3.29	0.41	—0.71	+2.96
Do				0.00			—3.85		—3.85	—1.30		+2.55
t. 17, 1873	2.60	4.00	+1.40				1.08	—1.52		2.70	+0.10	+1.62
pt. 21, 1874	3.32	5.15	+1.83	4.25	+0.93	—0.90	2.81	—0.51	—1.44	5.30	+1.98	+2.49
ɔv. 10, 1874	3.02	3.80	+0.78	2.70	—0.32	—1.10	1.00	—2.02	—1.70	3.15	+0.13	+2.15
ɔv. 2, 1875	5.82	7.60	+1.78	9.05	+3.23	+1.45	5.90	+0.08	—3.15	8.10	+2.28	+2.20
ɛc. 22, 1876	1.30	3.70	+2.40	3.20	+1.90	—0.50	1.25	—0.05	—1.95	4.05	+2.75	+2.80
n. 1, 1877	1.00	1.70	+0.70									
ɨt. 13, 1877	3.40	5.00	+1.60	4.50	+1.10	—0.50	3.20	—0.20	—1.30			
ɨt. 22, 1878	5.92	7.25	1.33				3.75	—2.17				
ɨt. 10, 1879	2.68			2.40	—0.28		0.55	—2.13	—1.85			
ɔv. 10, 1879	3.40	4.10	+0.70	2.60	—0.80	—1.50	1.25	—2.15	—1.35			
ɨt. 29, 1880	5.90	9.05	+3.15	7.00	+1.10	—2.05	5.20	—0.70	—1.80	7.95	+2.05	+2.75
ɔv. 30, 1880	5.70	9.00	+3.30	9.40	+3.70	+0.40	7.55	+1.85	—1.85			
ɔpt. 10, 1881	5.40	6.35	+0.95	5.50	+0.10	—0.85	3.00	—2.40	—2.50	3.65	—1.75	+0.65
ɛc. 19, 1882	7.30	8.60	+1.10	9.70	+2.40	+1.10	5.90	—1.40	—3.80	7.60	+0.10	+1.70
ɛpt. 30, 1883	4.70	6.40	+1.70	6.80	+2.10	+0.40	4.20	—0.50	—2.60	2.90	—1.80	—1.30
ɛpt. 23, 1884	7.10	8.45	+1.35	9.80	+2.70	+1.35	6.80	—0.30	—3.00	5.10	—2.00	—1.70
ɛt. 20, 1885	8.30	8.00	—0.30	10.00	+1.70	+2.00	6.40	—1.90	—3.60	4.90	—3.40	—1.50
ov. 12, 1886	3.80	3.00	—0.80	5.90	+2.10	+2.90	2.55	—1.25	—3.35	0.00	—3.80	—2.55
ept. 10, 1887	3.87	3.30	—0.57	6.45	+2.58	+3.15	4.17	+0.30	—2.28	—0.15	—4.02	—4.32
ct. 14, 1887	3.75	2.60	—1.15	6.00	+2.25	+3.40	3.60	—0.15	—2.40	—0.60	—4.35	—4.20
ov. 20, 1887	2.13	0.15	—1.98	3.50	+1.37	+3.35	1.52	—0.61	—1.98	—3.91	—6.04	—5.43
an. 1, 1888	1.80	—0.18	—1.98	4.50	+2.70	+4.68	2.12	+0.32	—2.38	—1.32	—3.12	—3.44
ct. 15, 1888	5.09	4.60	—0.49	7.95	+2.86	+3.35	5.50	+0.41	—2.45	2.40	—2.69	—3.00
ct. 23, 1889	2.55	1.60	—0.95	5.10	+2.55	+3.50	2.80	+0.25	—2.30	—0.70	—3.25	—3.50
lay 25, 1890	9.10	10.00	+0.90	13.60	+4.50	+3.60	9.30	+0.20	—4.30	9.00	—0.10	—0.30
ct. 13, 1891	2.10	1.30	—0.80	5.70	+3.60	+4.40	1.40	—0.70	—4.30	—1.20	—3.30	—2.60
ov. 8, 1891	2.40	0.90	—1.50	4.80	+2.40	+3.90	0.60	—1.80	—4.20	—2.50	—4.90	—3.10
ct. 27, 1892	3.90	1.20	—2.70	6.50	+2.60	+5.30	1.30	—2.60	—5.20	0.00	—3.90	—1.30
Do							0.70			—1.00		—1.70

TABLE No. 2.—*Comparative gauge readings at Cairo and Helena.*

Date of crest passing Cairo.	Cairo reading.	Helena reading	Difference.	Rate of rise in five days at Cairo.
September 10, 1889	14.44	13.40	—1.04	6.78
October 28, 1885	14.93	13.50	—1.43	4.81
December 3, 1891	15.60	15.00	—0.60	3.20
November 23, 1879	15.85	16.50	—0.35	8.35
September 9, 1882	15.32	16.50	+1.18	2.34
February 27, 1872	15.38	15.80	+0.42	2.09
August 11, 1879	15.30	15.40	+0.10	1.57
September 12, 1880	14.52	15.40	+0.88	1.00
January 12, 1872	15.20	15.20	0.00	0.50
May 25, 1889	20.65	19.75	—0.90	7.65
August 24, 1891	19.40	19.70	+0.30	6.20
October 5, 1884	19.65	20.20	+0.55	5.72
August 4, 1884	19.00	20.05	+1.05	2.48
December 27, 1889	20.40	19.00	—1.40	2.20
September 8, 1885	19.05	18.70	—0.35	2.20
September 25, 1890	20.50	21.10	+0.60	2.20
August 17, 1885	20.47	20.45	—0.02	2.15
July 20, 1872	19.10	20.30	+1.20	5.10
September 25, 1875	19.30	20.80	+1.50	2.90
July 5, 1879	19.75	20.80	+1.05	2.35
October 14, 1881	19.60	19.90	+0.30	1.40
July 25, 1881	20.10	21.50	+1.40	1.06
December 16, 1875	19.80	20.70	+0.90	0.80
December 22, 1885	24.75	23.70	—1.05	6.15
March 26, 1889	25.31	25.45	+0.14	3.46
November 25, 1890	24.40	24.90	+0.50	3.30
April 25, 1889	24.16	25.45	+1.29	3.06
June 27, 1891	25.50	26.90	+1.40	2.50
January 6, 1892	24.00	24.40	+0.40	2.30
June 21, 1890	25.30	27.00	+1.70	1.80
June 20, 1888	25.60	27.28	+1.68	0.40
June 15, 1872	24.70	26.40	+1.70	3.15
July 8, 1878	25.30	27.85	+2.55	1.22
June 8, 1880	24.30	25.55	+1.25	1.11
July 7, 1881	25.52	27.20	+1.68	1.00
July 1, 1873	25.25	27.55	+2.30	0.49
January 24, 1892	30.30	29.40	—0.90	9.70
January 11, 1886	30.23	29.95	—0.28	5.83
February 24, 1888	29.02	29.20	+0.18	5.00
January 21, 1889	30.66	31.35	+0.69	4.40
July 1, 1886	29.60	30.30	+0.70	3.32
December 2, 1889	29.52	28.75	—0.77	2.90
June 22, 1885	30.80	33.20	+2.40	2.60
June 14, 1889	29.04	29.95	+0.91	2.16
December 17, 1878	30.00	30.80	+0.80	9.50
June 22, 1881	30.84	31.90	+1.06	6.00
January 30, 1883	30.70	31.10	+0.40	5.87
July 3, 1877	29.37	32.48	+3.11	2.37
July 14, 1873	29.06	30.40	+1.34	1.90
March 22, 1877	30.82	32.00	+1.18	0.62
June 24, 1889	34.50	34.10	—0.40	6.51
May 29, 1891	34.10	35.20	+1.10	3.00
January 31, 1884	35.28	36.20	+0.92	2.78
July 9, 1880	34.06	34.70	+0.64	5.96
January 17, 1878	35.72	37.90	+2.18	5.12
October 7, 1876	34.22	36.83	+2.61	3.10
February 9, 1879	34.15	36.20	+2.05	3.00

E No. 3.—*Comparison of gauge readings at Cairo, Helena, mouth of White River, and Vicksburg.*

Date of crest passing Cairo.	Cairo gauge.	Helena gauge.	White River gauge.	Difference White River and Helena.	Vicksburg gauge.	Difference Vicksburg and White River.
ary 12, 1872	15.22	15.20				
uary 27, 1872	15.38	15.80				
ust 11, 1879	15.30	15.40	14.50	—0.90		
ember 23, 1879	15.85	15.50	14.00	—1.50		
ember 12, 1880	14.52	15.40	15.80	+0.40		
ember 9, 1882	15.32	16.50	16.50	0.00	14.10	—2.40
ber 28, 1883	14.93	13.50	14.90	+1.40	10.10	—4.80
ember 10, 1889	14.44	13.40	15.80	+2.40	11.80	—4.00
ember 3, 1891	15.60	15.00	17.20	+2.20	12.40	—4.80
20, 1872	19.10	20.30				
tember 25, 1875	19.30	20.80	22.85	+2.05	21.90	—0.95
ember 16, 1875	19.80	20.70				
y 5, 1879	19.75	20.80	21.40	+0.60	20.80	—0.60
y 25, 1881	20.10	21.50	22.80	+1.30	19.90	—2.90
ober 14, 1881	19.90	21.40	21.40	+1.30	19.20	—2.20
gust 4, 1884	19.50	20.05	22.20	+2.15	18.70	—3.50
ober 5, 1884	19.65	20.20	22.40	+2.20	18.00	—4.40
tember 8, 1885	19.05	18.70				
gust 17, 1885	20.47	20.45	22.80	+2.35	18.35	—4.45
y 23, 1889	20.65	19.75	23.88	+4.13	19.50	+4.33
ember 27, 1889	20.40	19.00				
tember 25, 1890	20.50	21.10	25.70	+4.60	22.50	—3.20
gust 24, 1891	19.40	19.70	21.50	+1.80	17.50	—4.00
ne 8, 1880	24.30	25.55	27.60	+2.05	26.50	—1.10
ly 7, 1881	25.52	27.20				
cember 22, 1885	24.75	23.70	24.51	+0.81	20.05	—4.46
ne 20, 1888	25.60	27.38				
arch 26, 1889	25.31	25.45	32.98	+7.53	30.30	—2.68
pril 25, 1889	24.16	25.45	28.93	+3.43	26.10	—2.85
ne 21, 1890	25.30	27.00	30.10	+3.10		
ne 27, 1891	25.50	26.90	31.80	+4.00	29.40	—2.40
nuary 6, 1892	24.00	24.40	27.30	+2.90	24.60	—2.70
ly 14, 1873	29.06	30.40				
arch 22, 1877	30.82	32.00	33.80	+1.80		
ly 3, 1877	29.37	32.40				
ecember 17, 1878	30.00	30.80				
ebruary 22, 1881	30.84	31.90	34.40	+2.50	31.50	—2.90
anuary 30, 1883	30.70	31.10				
ne 22, 1885	30.80	33.20	36.90	+3.70	33.70	—3.20
ly 1, 1886	29.60	29.95	32.40	+2.45	30.30	—2.10
anuary 11, 1886	30.23	30.30	31.00	+0.70	28.10	—2.90
ebruary 28, 1888	29.02	29.20	31.68	+2.48	29.55	—2.13
anuary 21, 1889	30.66	31.35	37.10	+5.75	33.78	—3.32
une 14, 1889	29.04	29.95				
ecember 2, 1889	29.52	28.75	33.10	+4.35	28.70	—4.40
anuary 24, 1892	30.30	29.40	31.60	+2.20	29.10	—2.50
ly 10, 1870	34.22	36.83	42.35	+5.52	40.10	—2.25
anuary 17, 1878	35.72	37.90				
ebruary 9, 1879	34.15	36.20				
uly 9, 1880	34.06	34.70	36.80	+2.10	34.30	—2.50
April 3, 1884	35.28	36.20	38.20	+2.00	36.20	—2.00
une 24, 1889	34.50	34.10	37.65	+3.55	34.40	—3.25
May 29, 1890	39.10	35.20	39.60	+4.40		

TABLE NO. 4.—*High-water readings at Cairo and Helena.*

Date of crest passing Cairo.	Cairo.	Helena.	Difference.	Rate of rise in five days at Cairo.	W...
February 27, 1883	52.17	46.90	—5.27	0.38	....
February 26, 1882	51.87	47.1	—4.77	3.47	....
February 29, 1884	51.80	47.00	—4.80	0.64	....
April 19, 1886	51.00	48.00	—2.90	1.00	....
May 10, 1893	49.30	47.90	—1.40	0.90	....
March 12, 1890	48.80	47.70	—1.10	1.40	....
March 10, 1887	48.48	46.30	—2.18	1.35	....
April 27, 1892	48.20	45.70	—2.50	2.70	....
February 2, 1882	47.74	46.70	—1.02	1.00	....
April 26, 1874	47.37	45.82	—1.55	2.27	....
March 1, 1891	46.20	44.75	—1.50	0.30	....
April 6, 1876	46.38	44.85	—1.53	0.53	....
April 20, 1881	45.80	43.74	—2.06	3.20	....
February 4, 1888	45.25	42.80	—2.45	2.50	....
February 5, 1876	45.19	43.00	—2.19	2.19	....
March 22, 1883	44.60	43.70	—0.90	0.64	....
March 28, 1874	43.97	42.42	—1.55	2.87	....
March 21, 1875	43.66	42.40	—1.26	2.00	....
May 23, 1882	42.52	41.75	—0.77	0.85	....
February 26, 1873	41.55	40.00	—1.55	2.12	....

APPENDIX 4.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 31, 1894.

SIR: I have the honor to submit the following report upon works in charge of this office for the year ending May 31, 1894:

In addition to other duties the office has charge of the fourth district, Mississippi River, for the execution of works in accordance with the approved plans, specifications, and recommendations of the Mississippi River Commission. The district extends from Warrenton, 7¼ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, and comprises 484 miles of the river.

The works under the Commission include improvements of the harbor of Natchez and Vidalia, Mississippi and Louisiana; channel improvements at the junction of the Mississippi, Red, and Atchafalaya rivers near Turnbull Island, Louisiana; improvement of the harbor of New Orleans; the construction, repair, and maintenance of a portion of the levee system of the district; the maintenance of certain gauges and certain surveys, observations, and other special work.

HARBOR OF NATCHEZ AND VIDALIA.

The rapid caving of the bank in Giles Bend, above Natchez, has narrowed the adjacent neck so there is danger that the river will eventually break through in high water and form a permanent cut-off. Should such cut-off take place it is apprehended that the river may change its course below by rapid erosion on the west bank, accompanied by accretion on the east bank. This might result in the destruction of a portion or all of the town of Vidalia, and in injury to the water fronts or landings at Natchez. The object of the contemplated works is to delay and if possible prevent the formation of the threatened cut-off across Cowpen Neck.

By the river and harbor act of July 13, 1892, an appropriation of $80,000 was made for this work.

On November 17, 1892, the following resolution was passed by the Commission:

"That it be recommended to the Secretary of War that the special appropriation for improving harbors of Natchez and Vidalia, or so much thereof as may be necessary, be expended in constructing a levee along the axis of Cowpen Point."

This recommendation having been approved, project for the levee was submitted on June 22, 1893. This project has been approved. It contemplates a levee similar in general construction to those of the main system of the lower river, with revetment work of brush at its outer end to prevent erosion by the current. The total length of this work will be about 3¾ miles. In order to interrupt erosion, should the outer end with its protecting revetment be lost by continued caving of the river bank, a short spur levee is to be thrown back at right angles to the main work to a point about 3,500 feet from the outer end. The outer face of this spur and the first

pes of the main levee adjacent to it are to be paved with rock. Syphons are to laid over the levee to prevent interruption of the drainage of the property above. The estimated cost of the work, including purchase of site, is $50,600. Detailed rveys have been made to determine the final location and boundaries of land required site for the levee.

It having been found impossible to arrange with the owner for the purchase of the nd needed for the work, about 100 acres, at a price considered reasonable, appli- tion was made on October 5, 1893, to have the land condemned. It is understood at proceedings to this end have been begun by the Department of Justice. The ving and recession of the bank line in Giles Bend, above the neck, seem to have en considerably less rapid during the past year than formerly, while the caving on e opposite bank in Marengo Bend and below has been very rapid. It is possible at this latter caving and consequent increase in length of the river and diminution slope in this vicinity may be the cause of the decreased action in Giles Bend, and at the construction of the levee will prove effective in preventing the cut-off with- it the extensive revetment work now contemplated. For this reason no estimate submitted at present for the amount that can be profitably expended in addition the amount already available.

Money statement.

une 1, 1893, balance unexpended	$78,579.53
ay 31, 1894, amount expended during fiscal year	858.34
une 1, 1894, balance unexpended	77,721.19

UNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, NEAR TURNBULL ISLAND, LOUISIANA.

A detailed description of the difficulties in this vicinity which the improvements re designed to rectify will be found in the annual report of 1892. In general terms, hese difficulties consist in the filling up of Old River, which is the only navigable ntrance from the Mississippi to the Red and Atchafalaya rivers and their tributa- ies, so that low-water navigation is impeded and at times entirely obstructed.

This filling up is attributable in part to the deposit of sediment during high water, aused by irregular variations in the strength and direction of the current in Old iver, and in part to the caving in or sliding down of the soft banks adjacent to the hannel during low water.

The complete system of works contemplated with a view to correcting these diffi- ulties comprises the following objects:

To check the enlargement of the Atchafalaya, and limit its outlet capacity by a ystem of low relief dams or sills, located near the head of this outlet river and just elow the point where the Bayou Des Glaises comes in.

To separate the Red from the Atchafalaya during low water and up to a 10-foot tage by means of a low dam at the west end of Turnbull Island, which for all stages elow the crest of the dam would deflect the Red around the upper side of Turnbull sland through Upper Old River.

To complete the separation by cutting a canal across Carrs Point and obstructing he lower end of Upper Old River, thus making the Red a tributary and the Atcha- alaya an outlet, separated from each other at low stages; while the conditions at igh stages are not to be materially modified.

The plan also contemplates maintaining low-water navigation through Lower Old River, if practicable, by dredging or otherwise, until the above system of works is ompleted so far as to become effective.

The entire Red and Atchafalaya system, whose only outlet is now through the chan- nels which these works are designed to improve and maintain, comprises a total length of about 4,300 miles of navigable river in those stages in which there are at present no difficulties in Lower Old River. In low water, when such difficulties are experienced, the navigable portion of the Red and Atchafalaya system is about 345 miles for a 3-foot draft and 132 miles for a 5-foot draft.

At the date of the last annual report the following work had been done:

Two sill dams near the head of the Atchafalaya, with the shore protection, con- necting levees, and wing levees, had been completed.

The sill or foot mattresses and shore-protection work of the Red River Dam had been finished and dam constructed temporarily for a height of 3 feet above the zero of Barbres gauge with a view to increasing the effect of scour in Upper Old River during the falling stage of the river after the high water of 1891. The dam was

partly cut down again to afford a navigable channel over it for the low-water season of 1891, leaving it at a height of about 5 feet below the zero of Barbres gauge and a width of 450 feet.

The site of the Carrs Point canal has been surveyed and timber cut along the center line.

Some dredging had been done in Upper Old River and the usual work of building temporary spur dikes and of dredging, with a view to maintaining low-water navigation through Lower Old River, had been done each low-water season.

A telegraph line connecting the Government depot at Barbres Landing with Melville, La., on the Texas and Pacific Railway, the nearest telegraph station, has been constructed.

Contract had been made, after public advertisement, with the Bucyrus Steam Shovel and Dredge Company, of Bucyrus, Ohio, for a hydraulic dredge especially designed for opening and keeping open a low-water channel in Lower Old River. The levee between the ends of the two sill dams in the Atchafalaya on the Simmesport side had been partially enlarged and repaired.

The dredge for this work was to have been delivered on August 1, 1893, but on account of various delays, partly due to the removal of the company's shops to South Milwaukee, Wis., the dredge did not arrive at Old River until November 1, and she was not even then entirely completed.

During the falling stages of the river a considerable current existed in Lower Old River toward the Mississippi, and the tug *Comstock* was sent up to assist scour and removal of sediment by steaming through back and forth over the shoal places and so stir up the sand by the action of her wheel. The favorable conditions of the current assisted by the tug resulted in there being no trouble in the channel from sand deposits.

It has been known for some time that the ponds and sloughs resulting from the partial filling up of the old bed of the Mississippi adjacent to the present channel, which become filled during high stages of the river or by rain, retain water as the river falls, so that at low stages the level of the water in these ponds is sometimes several feet above the water surface in the channel. This fact has been verified by running levels, and it is no doubt true that the sliding down of the soft mud deposits forming the banks of the channel, to which the troubles in Lower Old River are largely attributable, is aggravated by this retained water, which keeps the banks soft and adds to their weight.

During the past season a number of ditches were cut to drain out this water, and the result appeared to be beneficial.

The new dredge not being ready, and it being evident that dredging would have to be resorted to to maintain the channel in the vicinity of the sloping banks, the dredge *Pah-Ute* began work on September 6, and was operated by the crew of the steamer *General Newton* until November 2, 1893.

Upon arrival of the new dredge she was put at work in Lower Old River with the consent of the contractors. She was not yet fully completed, and the conditions of the river were not favorable for making the test for capacity. The expense of operating her was borne by this office, the contractors having a representative on hand to superintend alterations and work necessary to complete the dredge.

She continued in operation until January 24, 1894 (with several interruptions for repairs and alterations to machinery), when the test for capacity, etc., having been satisfactorily made, and in accordance with the terms of the contract, she was accepted from the contractors and taken to New Orleans to be laid up. Several minor alterations and repairs have been made, and the dredge has been further tested by both night and day runs. She is now ready to resume work in Old River as soon as the stage of the water will permit. The following are the specifications of the contract under which the dredge was built:

Dredge for the fourth district, Mississippi River.

WORKS OF IMPROVEMENT, JUNCTION OF RED, ATCHAFALAYA, AND MISSISSIPPI RIVERS.

SPECIAL CONDITIONS.

1. Description of work.—The work is located in the fourth district, Mississippi River, in the vicinity of Turnbull Island, Louisiana, near the west bank of the Mississippi River, about 200 miles above the city of New Orleans by river. The nearest regular landing on the Mississippi River is Red River Landing, and facilities for shipping supplies and freight to or from either direction by Mississippi steamboats are good. Steamboats in the Red, Black, Ouachita, and Atchafalaya rivers trade also frequently pass the works. The nearest railroad stations and telegraph offices are at Melville, 40 miles down the Atchafalaya River; Bayou Sara, 35 miles

own the Mississippi; and Natchez, 65 miles above on the Mississippi. A Government telephone line runs from Barbres Landing, near the works, to Melville. There re machine shops and facilities for repairs at both Natchez and New Orleans, but here are no docks capable of taking vessels of considerable size nearer than New rleans. The annual variation in the height of the water is from about 1 foot below ero of the gauge to about 45 feet above. Work can be carried on at any season of the ear except when interfered with by extreme high water. White labor is easily btained from November till May, but during the summer season colored labor has o be depended upon principally. The fuel available and used by steamboats in this icinity is soft Pittsburg and Alabama coal and ash wood, principally the former. he river water is usually heavily charged with mud, and at certain seasons the vater of Red River contains a considerable quantity of alkaline salts. All parts of he work are well sheltered from the effects of storms. The dredging work at resent contemplated consists in excavating and maintaining a channel in Upper Old River. This channel is to have a width of not less than 75 feet at bottom and a depth of not less than 5 feet below the zero of the gauge at Barbres Landing.

2. *Material to be dredged.*—Turnbull Island was formerly a peninsula, and the Mississippi River flowed around its western end. Since it was made an island by the main river cutting through across the narrow neck which formerly united the island to the east bank, the old river has become largely filled up with soft and recent river deposit, and it is through this material that the channel is to be excavated. A channel existed in Upper Old River up to about 1874, and the sediment that is now to be removed has been almost entirely deposited since that date. This sediment consists of a fine soft clay, with a small proportion of very fine sand. It is almost liquid to a considerable depth and will stand only on a very flat slope. A pole can be easily pushed down into it by hand to a depth of 8 or 10 feet or more. At greater depth it is probable that the mud is more compacted by time, and sand deposits will no doubt be found in places. The dredge should therefore be capable of working in either soft mud, sand, or stiff clay, though the requirement of being able to handle a very large quantity of very soft mud in a given time is most important. A few trees and logs may be found, but so far as known there are very few obstructions of that kind. No bowlders, rock, or hardpan will be encountered. The total depth of excavation will be from 10 to 19 feet. It is proposed to discharge the dredged material in low sloughs and ponds that have been left in the natural process of filling up the river bed. The elevation of the bars or banks over which the material is to be discharged is from 20 to 35 feet above the bottom of the cut, and the greatest distance of discharge will not exceed 1,000 feet. The bars are very flat, generally soft, and thickly grown up with young trees, which can be cleared off, if necessary. The work will probably be done mainly in a gentle current or in slack water, and there will be no "sea," but to enable work to be continued at all times the dredge should be able to work in a strong current flowing in any direction with respect to the position of the dredge. It may become necessary to occasionally move the dredge during low water to enable steamboats to pass.

3. *General requirements of dredging apparatus.*—To adapt the dredging plant to the above conditions it must conform to the following general requirements:

4. *Hull.*—This will preferably be built of wood, in the most suitable manner and of the most durable and suitable materials available for the purpose. The hull must be as small as practicable consistent with the weight of machinery to be carried and the limit of draft, in order to secure facility in handling and to diminish the obstruction to passing boats as much as practicable while working in the channel. No less than two water-tight bulkheads should be provided to diminish the danger of sinking in case of leakage. The hull must be sufficiently stiff to resist all strain which might result from grounding on soft or sand bottom, but need not be designed to stand any heavier sea than is found on the Mississippi River. The draft must not exceed 5 feet while working or moving with full supplies on board.

5. *House.*—This must be provided with ample and comfortable sleeping accommodations, adapted to the climate, for a full double crew to run the dredge day and night. There will also be two commodious extra staterooms, with closets and necessary conveniences, one for the inspector or other person in immediate charge, and one reserved. There will be a suitable storeroom, and closets, cookroom, ice chests, and dining room of sufficient capacity for full double crews, and not less than three water-closets. A complete outfit of bedding and necessary furniture and of cooking and table furniture will also be furnished by the contractor. There will be an ample and convenient shoproom fitted with blacksmith's forge complete, bench, vise, and hand-power drilling machine, all of sufficient capacity and adapted to making repairs necessary in ordinary working. Storage for sufficient fuel for ten days' run should be provided.

6. *Steam boilers.*—These must be adapted to the character of the water and fuel available at the works and should be of the usual river type. They will be of steel and will be required to conform to the rules of the U. S. steam-boiler inspectors,

and the proper certificate from a U. S. steam-boiler inspector as to material, design, construction, and tests must be furnished. Reserve boiler power must be provided to enable the dredge to continue working in case of accident. All fixtures and fittings for the boilers must be complete and in conformity to the most approved modern practice.

7. *Steam engines and pumps.*—These must be of the best construction and of the forms best adapted to the conditions for efficient and economical working, and they will be fitted with the most approved fixtures of all kinds complete. All principal steam cylinders will be provided with necessary connections and attachments for taking indicator diagrams to Tabor, Crosby, or Thompson standard indicator.

8. *Electric-light plant.*—An electric-light plant, consisting of separate boiler, engine, dynamos, and lamps, of a full capacity of not less than 25 16-candle-power incandescent lamps, and 3 full-power arc lamps, will be provided and put up to enable the dredge to be operated at night. This plant to conform in all respects to the best approved practice.

9. *Propelling power.*—The dredge may have its own propelling power or be designed to be moved by a tug or towboat; but whichever method be adopted, facility of movement will be especially required. Bilge connections for steam pumps, a sufficient number of fixed steam siphons of ample capacity, and fire hose with nozzles will be required; all to have suitable fixtures and connections in order to provide ample security against danger of sinking or from fire.

10. *Dredging apparatus proper.*—The particular kind or system of dredge is not specified, but whatever pattern is adopted the very best materials and most thorough and careful construction throughout will be required in order to secure the greatest capacity, efficiency, and durability. The dredge must have a practical capacity of not less than 300 cubic yards of material per hour, with a double crew, when working in soft mud and discharging over a bar or bank not less than 10 feet above the water surface, with point of discharge not less than 300 feet distant horizontally from point where dredged material is taken from. The capacity of the dredge will be determined by means of observations to determine the percentage of settlement in the discharged material and the rate of discharge, or otherwise as may be agreed upon. It must be capable of working effectively in stiff clay and sand. It must be capable of cutting its own way and opening the channel during low water, and should be able to work in all depths of water up to 30 feet, or as deep as may be practicable. It must be able to discharge the material on either side at a distance of 1,000 feet, and over a bank at a maximum height of 35 feet above the bottom of the cut, but it may also be adapted to discharging by the side of the cut when this can be done without danger of the material running back into the cut. It must admit of easy and rapid handling in a narrow channel in shoal water and where there may be a swift current. Spare parts or duplicates of all portions of the entire apparatus that may require renewal during the first six months' use of the dredge after its acceptance will be required.

11. *Construction, delivery, and operation.*—The dredge is to be built, and delivered at the works entirely at the contractor's expense, at as early a date as practicable. The bidder will state the date at which he is able to make delivery and the date of delivery will be considered in determining the bid to be accepted.

The material used and all parts of the apparatus are to be subject to inspection during the construction by an agent of this office and full information is to be furnished as to where material may be seen and the time and place of constructing the various parts, to enable such inspection to be made.

Upon completion and delivery of the plant it will be subject to a thorough test of not less than ten days' continuous operation at such locality on the works at Turnbull Island as will thoroughly demonstrate its efficiency and develop its defects. Any breakage that may occur or defects that may be found must be at once remedied, and the apparatus will not be accepted until it has operated successfully and satisfactorily for at least ten days continuously. The cost of operating during the trial and up to the time of final acceptance, except the cost of alterations and repairs, will be borne by the United States. If the apparatus is not accepted, or if it or any part of it should sink or become in any way an obstruction to navigation, the whole plant or such part as may be an obstruction must be removed at once by the contractor.

12. *Proposals.*—Bidders are requested to submit proposals for supplying apparatus to fulfill the above conditions as nearly as may be practicable, accompanied by guaranty on form supplied. The proposition should be accompanied by complete drawings and detailed descriptions of material to be used and methods for construction of the hull, house, boilers, pumps, engines, propelling power, if any, electric-light plant, dredging and discharging apparatus proper, arrangements for fire protection, and other parts to enable the proposal to be clearly understood in all its details. The name or make of pumps, engines, electric-light plant, and all machinery and fixtures which it is proposed to furnish, when these are to be of a pattern or

ake now regularly manufactured, must be clearly specified. Any proposed modifications of the general requirements as above given must be fully explained. In ase of proposals to furnish apparatus similar to any previously built, the place and ate of construction of such apparatus, and the place, date, and results of its operations, must be fully stated.

In the new apparatus the design and construction must be such as to fully remedy ll defects in former plants; and such defects and methods proposed for their remedy ust be stated. A detailed list must be given of the parts it is proposed to deliver n duplicate. A careful estimate must be given of the number of the crew required, he consumption of fuel, the capacity, and all the expenses of operating the proposed lant. Propositions will also be considered for purchasing a dredging plant already uilt, in whole or in part, that may be adapted to the requirements of the work, and or the rental of such apparatus. Bids for new apparatus which do not conform to he above general requirements as to detailed drawing and description can not be onsidered, but in case of plant already partly or wholly constructed which is offered for sale or rental detailed drawings and descriptions of such parts as can be inspected will not be required.

13. Acceptance of bid and contract.—The bid which is most advantageous to the United States will be accepted, the right being reserved to reject any and all bids, and to make such modifications in the details of the specifications by mutual agreement before entering into contract as may be found necessary to make the specifications clear and explicit and to adapt them to the special form of apparatus to be furnished.

Contract will be entered into with the successful bidder in the usual form with more detailed specifications and the proper bonds.

The contractor will be required by the terms of this contract to fully protect the United States against all claims for damages or royalty on account of use of patents or inventions.

DETAILED CONDITIONS.

1. The dredging plant.—To be supplied under this contract, to conform to the foregoing general and special conditions, is to consist of a self-propelling dredge of the suction type, fitted with necessary discharge apparatus and all proper accessories.

2. Hull.—To be 95 feet long, 27 feet wide, and 7 feet 6 inches deep. To be built mainly of long-leafed yellow pine or other timber equally durable and suitable for the purpose. All timber and lumber used in the hull or other parts of the dredging apparatus to be sound and free from sap, shakes, large or loose knots, or other defects which would impair its efficiency or durability for the particular part of the dredge where used. The dimensions of all timbers, frames, planking, decking, and other parts must be ample, and the framing and fastenings to be of the best to insure ample strength and stiffness. Two longitudinal and two cross bulkheads to be provided. The bulkheads to be carried up to the deck and to be thoroughly calked, forming nine independent water-tight compartments. Drainage openings to be cut in bottom beams of each compartment, so each compartment can be freed from water by one bilge suction. The best quality of oakum to be used in calking. Bottom, sides, rakes, spud well, bulkheads, and main deck to be thoroughly calked. Inside of hull and all surfaces below deck to be given two good coats of lime whitewash mixed in salt in proper proportions before launching. All parts of bottom, sides, and rakes of hull, rudders, and spud well below load-water line to be given two good coats of coal tar applied hot. Above water line hull to have two good coats of best red-lead paint. All necessary sea connections in hull below water line to be made before launching. Two hog chains, one on each side, of proper design, with necessary braces, to be provided, to give additional stiffness to hull.

3. House.—The house will be double-decked and will extend nearly the full length of the dredge so as to afford shelter for all parts of the machinery. The propelling engine room and main-engine room and pump rooms will be entirely housed in, with sufficient windows for light and ventilation, and suitable doorways. The sides of boiler space to be housed up to within 3 feet of upper deck. (Auxiliary engines and winding drums to be housed on sides and rear, with curtain to protect front from weather when not running omitted; tarpaulin to cover engine substituted.) Fire room to be open. The house on lower deck will be given such width as to leave a clear passage on lower deck about 4 feet wide on each side from forward as far aft as propelling engine room. (Tool room and workshop omitted.) Engine storeroom and two water-closets aft to be provided on lower deck.

Upper deck to extend nearly full width of hull and to have staterooms and mess accomodations, kitchen, storerooms, bathroom, closet, ice chest, etc., according to drawings. Roof of upper deck to extend nearly full length fore and aft and same width as upper deck. A skylight with hinged side windows to extend from front of pilot house to near main chimneys. Pilot house will have rear door, windows all around, and to be complete with usual bells and speaking tube to engine room.

The house throughout to have ample provision of doors and windows for light and ventilation.

All passages and open spaces on upper deck not inclosed to be covered with heavy deck canvas laid in thick white lead or yellow ocher paint and securely nailed down. Roof of upper deck, skylight, and pilot house to be covered in same manner. Two flagstaffs to be provided—one on pilot house, one aft.

Drainage of upper deck and roofs to be provided for by sufficient tin scuppers and leader pipes in manner usual in steamboat construction.

4. Coal bunkers.—Ample provision will be made in hold of dredge for a supply of coal equal to not less than ten days consumption, and requisite coal hatches, provided with cast-iron rings and gratings, will be placed in main deck.

5. Steering gear.—The dredge will be provided with 2 rudders, the stocks of which will extend to roof of engine room and be provided with tiller and coupling rod. The steering wheel will be placed in pilot house, and all wire ropes, rods, and sheaves required to connect with rudders will be supplied.

6. Spud.—To be of suitable timber, 18 inches square, with steam cylinder for raising, and of sufficient length to hold dredge when operating in 30 feet of water; to be arranged so dredge can work ahead without raising spud for each cut; to have automatic gripping cam and holding cam with all necessary pipes, valves, connections, and operating handles, so as to be under complete control; to have iron point. (To be treated with two good coats of coal tar applied hot. Omitted. Would interfere with grip of lifting cam.)

7. Fenders.—Dredge to have 12 movable wooden fenders, 6 on each side, with proper cleats and lashings. These fenders to be of oak or other suitable timber, not less than 8 inches square at lower end, and to be lashed to iron cleats on upper deck. To extend down to well below the fender streak of hull.

8. Kitchen and table furniture.—Kitchen to have suitable range and sink, and all necessary cooking furniture and utensils of plain substantial quality. Table for crew's mess to have oilcloth cover, stools or benches, and furniture of "granite ware." Knives and forks and spoons of plain durable quality. Table for officers' mess to have plain chairs, 2 plain white and 2 colored cloths, furniture of plain substantial white ware, and glass, knives, forks, and spoons of better quality than crew's mess, and supply of colored napkins.

9. Room furniture.—Crew's quarters to have plain stools. Each bunk to have a good mattress, 1 pillow, 2 plain colored pillow covers, 2 good blankets, and 2 pairs plain colored single sheets. One wash room to be provided for crew with wash basins and plain roller towels.

Officers rooms to have plain oilcloth or linoleum covered floors, 1 plain chair and washstand, wash bowl and pitchers (plain mirror should be added). Each bunk in these rooms to have 1 pillow and 1 spring mattress, 1 moss or hair mattress, 2 pairs plain colored sheets, 2 plain colored pillowcases, 2 blankets.

Room for inspector and reserved room to have linoleum covered floor, plain rug, 2 chairs, set of toilet furniture, looking-glass, spring mattress for bed, hair or moss mattress, 2 pairs of white sheets, 2 pillows, 4 white pillow covers, 2 blankets, and 1 coverlet.

All bunks and beds on boat to have mosquito nets.

10. Bathroom.—To have plain copper or zinc bath tub and flushing water-closet.

11. Running lights.—Brackets for these lights to be provided on smoke pipes, with tackle and a duplicate set of colored lamps, in accordance with law.

12. Boat and davits.—One skiff to be provided suitable for handling lines, anchors, etc. To be about 18 feet long by 5 feet beam, and to be strongly made of oak or cypress; to have 2 pairs of oars with patent oarlocks. One set of iron davits to be provided with blocks and falls and cradles complete so skiff may be hoisted up to roof.

13. Water tank.—An iron water tank will be provided and mounted and secured on roof, with capacity of not less than 3 barrels. It will have all necessary supply piping from pump and to kitchen, bathroom, and water-closet.

14. Painting.—In general all woodwork throughout and all metal work not finished is to be properly painted. All woodwork on lower deck of dredge will be given two good coats of white lead and oil paint, in addition to a priming coat inside and out. Paint to be mixed to dark lead color. All canvas covered roofs and decks to be given two heavy coats of similar paint after laying. All woodwork above lower decks to have one good coat in addition to priming coat, inside and out, of lighter lead color paint, with white trimmings. Inside of inspector's room and reserved stateroom may be plain white. All nail holes, knots, etc., to be properly puttied and filled.

Chimneys to be painted inside with best red lead paint, outside with chimney paint of suitable quality. All ironwork not finished to be properly painted or coal tarred. Boiler and pipe covering to be given two coats of lead paint, except where covered with Russia iron.

Bottoms of pontoons to be given two coats of best coal tar. Inside to have two coats of lime and salt whitewash. Remaining surfaces of pontoons to have two good coats of iron-ore paint. Discharge pipes to be coal-tarred outside.

15. Main boilers.—The two main boilers to be of the horizontal tubular type, with interior corrugated furnace flue. Each boiler to be of steel, shell 16 feet long, 60 inches in diameter, and adapted to regular working pressure of 120 pounds per square inch. Corrugated furnace flue to be 40 inches in diameter by 72 inches long. Shell to be in three sheets with double-riveted horizontal seams. To have 74 3-inch tubes. To have steam dome 30 inches in diameter by 30 inches in height; double riveted to boiler shell. To be fitted with steam gauges, water-gauge glasses, gauge cocks, spring "pop" safety valves, and all necessary hand and manholes, blow off, cleaning doors, and other necessary fixtures. A complete set of fire tools to be supplied for each boiler. Chimneys to be 30 inches in diameter and 35 feet long, with metal jacket 42 inches in diameter, covering that portion of their length between decks. To have hoods of suitable form at roof, and to be securely stayed. The chimneys to be of No. 8 iron for the first 12 feet from bottom and then No. 10 iron for 12 feet, and the top length of 11 feet to be of No. 12 iron. Chimneys to have dampers and suitable connections so the draft will be under control from the fire room. Cast-iron floor plates of diamond pattern to be furnished, laid in cement, to prevent danger from fire or injury to deck in removing ashes.

Boilers to be firmly secured to deck and covered as hereafter described.

Furnaces to be provided with an extra set of grate bars and an extra set of fire-door liners.

16. Auxiliary boiler.—To be of the vertical tubular type. Shell to be 40 inches in diameter by 6 feet high, and to be of sufficient capacity to operate the electric-light plant. To have spring "pop" safety valve, steam gauge, water gauge glass, gauge cocks, set of fire tools, duplicate of grate bars, and all necessary fixtures. Smoke pipe to be connected to one of main smoke pipes, with separate damper (was connected to main smoke pipe), or to have separate pipe, as may be hereafter determined. Steam connections to be made so auxiliary, or either or both main boilers may be used to operate the electric-light plant, steam capstan, steam siphons, or auxiliary engines.

17. Main driving engine.—To be compound condensing horizontal type. Stroke 20 inches. High-pressure cylinder 14½ inches in diameter, low pressure 26 inches in diameter. Bed frames of heavy hollow girder pattern, with main bearings for crank shaft cast on. These bearings to be fitted with phosphor bronze linings of approved design, adapted to adjustment for taking up wear. Crank shaft to be of steel 5 inches in diameter fitted with balanced crank disks of large diameter, truly faced and polished on rims. Piston rods and valve spindles to be of steel and all wearing surfaces to have ample bearing and proper adjustment for taking up wear. Steam pipe to be 3½ inches in diameter with convenient stop or regulating valve. Engine to be controlled by a high-speed governor. All parts to be well finished.

Engine to have foundation of heavy timbers well secured and fastened down to prevent vibration in running.

18. Auxiliary engines and winding drums.—The main cutter shaft and winding drums for hoisting the cutter and for swinging the dredge will be operated by a pair of auxiliary engines, on horizontal bed, placed forward on main deck. Cylinders to be 9 inches in diameter by 12 inches stroke. Their design, workmanship, finish, and fixtures will be in all respects equal to the main engines.

There will be two steel pinions fastened on the crank shaft for driving the hoisting and main shafts independently. The hoisting shaft will be of steel 4⅜ inches in diameter and will be fitted with wire rope drum gear and powerful holding brake and locking device for holding cutter in any position. This shaft to be worked by means of a clutch engaging with pinion on crank shaft. The main shaft to be of steel 3⅞ inches in diameter and to be fitted with a sprocket wheel for driving the cutter and two wire rope or chain drums for swinging the dredge. Each of these latter drums will be worked by a separate clutch.

All the operating handles for clutches and for throttle valves of auxiliary engines will be conveniently placed so the engineer from his station on the forward deck near auxiliary engine will have complete oversight and control of the operation of the dredge. Foundation of auxiliary engines and winding drums to be strongly built and fastened, and engine and drum-bed plates to be securely fastened down.

19. Cutter shaft and supporting frame.—The cutter to be supported at the apex of a strong timber and iron frame, projecting, when at work, from the bow of the boat. This frame to be strongly framed, braced, and fastened, so as to have ample strength to resist all horizontal and vertical and all bending or twisting strains to which it may be subjected. It will be hinged at the bow of the boat, and will have sufficient length to enable the dredge to work effectively in 30 feet of water, and it will also enable the dredge to dig her way when there is not sufficient depth to float her. Frame to be raised and lowered by wire-rope tackle, secured to a pair of shear

legs pivoted on bow of dredge and operated by winding drum. These shear legs will be guyed to stern of boat so they may be thrown back or "rigged inboard" when it is desired to raise the cutter frame to a high angle, as when moving the dredge from place to place.

The revolving cutter to consist of a conical steel casting, to which eight crucible cast-steel cutter blades are to be securely bolted, forming a conical cutter head about 54 inches in diameter at the base and 24 inches in diameter at the outer end. The cutter blades to be three-fourths inch thick, with strengthening ribs. The conical frame to have ample openings to allow passage of the water mixed with the material taken with it.

The cutter to be carried on the end of a hammered steel shaft 5 inches in diameter. The ends of the shaft will be turned to taper, accurately fitted to taper bore of cutter hub and secured by feather key and cross cutter. The cutter shaft to be in four sections, with bearings adapted to prevent end play, and cast steel couplings of ample strength, but not rigid. The outer bearing of the shaft to be in a steel casting which fits upon the outer end of the A frame and has opening and flange to receive outer end of suction pipe, and back disk to close rear of revolving cutter. It also has casing for the outer shaft bearing, which is made of hard-wood blocks boiled in oil, forming a bearing about 21 inches long. Shaft to have sleeve of phosphor-bronze firmly secured at bearing. Upper end of cutter shaft to have specially designed thrust bearing, secured and pivoted in casting fastened on forward deck of dredge.

A sprocket-wheel and pitch-chain connection to be provided from auxiliary engine to a shaft mounted on axis of pivots at base of A frame. From this shaft motion to be communicated to cutter shaft by bevel gears, with special device to insure correct operation of these gears in all positions of the cutter.

Fair leads, snatch blocks, and guide rollers to be provided so side chains of swinging dredge while at work may be led from anchors to forward part of main deck or to points some distance out on A frame, and thence to winding drums, as may be found most advantageous.

The A frame and all attachments and parts below water when working to be given two good coats of coal tar, applied hot.

20. Main suction pump—To be a centrifugal pump (Howell's patent, Edward's substituted), latest improved design, with suction and discharge openings 15 inches in diameter. Pump complete, with outer shaft bearing and driving pulley, to be on one bed-frame casting; to be lined with renewable cast-iron plates, and wings of pump runner to be renewable steel plates. Provision to be made for easy access to inside of pump so new lining plates or blades can be put in without removing shaft or taking down discharge pipe. Pump to be provided with necessary check valve and vacuum gauge and appliances to enable it to be readily primed and started. Connection between pump and main engines to be by a rubber belt of ample width and strength. Pump to be mounted on a heavy timber foundation and firmly secured.

21. Suction and discharge pipe and pontoons.—From the cutter to the pump the pipe will be 15 inches inside diameter, made of steel or iron of equal strength and endurance with heaviest portion of discharge pipe, with a sufficient length of flexible suction hose and proper couplings to enable cutter to be raised and lowered through entire vertical range of working and up to well clear of the water without disturbing the couplings. Provision also to be made for readily disconnecting the hose, should this be necessary to enable the frame to be raised to position for moving. Pipe to be turned to pump by smooth curve of large radius. From the pump to outboard connections discharge pipe to be spiral welded steel (spiral riveted, substituted in part, welded better), with flanged and bolted connections. Valve to be provided so either discharge may be used.

Elbow of large radius to be provided at outboard connection so discharge pipe may be led directly aft.

Discharge pipe outside hull to be spiral welded steel No. 12, 16 inches inside diameter, in from 14 to 24 foot lengths, with thick sheet rubber flexible connections 3 feet long, firmly secured to ends of pipe by screw clamps for all lengths, supported on pontoons. About 1,000 feet of discharge pipe to be provided; about 250 feet of the pipe to be supported on floating wooden pontoons; 10 small pontoons to be provided. These pontoons to be strongly made and fastened and well calked and made tight on bottom, sides, and deck; to be about 12 feet long, 6 feet wide, and 2½ feet deep. The pipe that is to be laid on land to have ends prepared for connecting by slipping one into the other. The pontoon for carrying discharge end of pipe to be about 30 feet long by 18 feet wide by 4 feet deep, or as large as may be found necessary; to be strongly made and fastened and calked and made tight on bottom, sides, and deck. To have shear legs fitted with guys and fastenings, and tackle with double purchase and hand-power winch for raising and lowering discharge pipe. To have water-ballast tank, if found necessary. This part of the discharge pipe to have flexible sections to permit the required motion. Pontoon to have spuds with hand hoists

to enable it to be secured in position in a current and to support about 150 feet of pipe.

Provision to be made for direct discharge ashore from dredge when practicable by support for about 50 feet of pipe from the dredge itself.

22. Propelling power.—To consist of two horizontal engines operated by steam from main boilers and connected to stern wheel of usual design and strong construction. Cylinders to be 15 inches in diameter by 60 inches (made 52 inches) stroke. To be provided with modern improved adjustable cut-off valve gear and automatic relief valves for cylinders. Usual signal bells and connections and speaking tubes to pilot house and to engineer forward to be provided.

Connections will be provided so these engines may be worked either from the engine room aft (or from forward engine room—omitted).

Propelling engines (to be connected to condenser so they may be worked condensing—omitted) or exhausting into atmosphere or smoke chimneys.

Indicator connections to be provided as required in special conditions.

23. Condenser and air pump.—To be Worthington combined duplex air and feed pump and condenser, having 7½-inch steam cylinder, 7-inch air cylinder, and 10-inch stroke; to be supplied with all valves, connections, and vacuum gauge necessary for efficient working. To be connected to main engines (and to propelling engines, so latter may be operated either high pressure or condensing, as desired—omitted).

24. Fire and bilge pump.—To be duplex of Worthington type, 6 by 4 by 6 inches, with all suitable connections, 100 feet of 4-ply rubber hose, pipes, nozzles, and valves and couplings to adapt it for purposes of washing down, extinguishing fires, supplying roof tanks, bathroom, and kitchen.

25. Steam capstans.—Two Providence steam capstans with double cylinders, 5 by 7 inches, to be provided and set, with convenient operating handles and necessary connections, with all necessary fair leads, bitts, and cleats.

26. Siphons.—A sufficient number of steam siphons with steam hose and connections to empty all of the compartments will be provided.

27. Anchors.—Two 400-pound kedge anchors to be provided with sufficient lengths of best tested five-eighths-inch refined iron chain to swing dredge by means of winding drums while at work.

28. Electric-light plant.—This to consist of an apparatus supplied by some reputable manufacturer, and to comprise dynamo, 25 incandescent lamps of 16-candle power, and two 2,000-candle power arc lamps, and one 2,000-power search light, all fitted up in best manner with suitable safety and regulating devices, in accordance with best modern practice.

All lamps to be placed as may be directed; search light to be under control of pilot.

Driving engine to be of modern high speed, automatic cut-off type, to be connected to take steam either from main or auxiliary boiler.

Dynamo to be set on sliding base, and both dynamo and engine to be firmly secured on solid foundations.

29. Boiler, cylinder, and pipe covering.—Boilers and main steam pipes to be well covered with approved material, preferably magnesia sectional covering for pipes (and "locomotive" covering for boilers. Magnesia used on boilers). Cylinders of main and auxiliary engines and of propelling engine to be covered or lagged in approved manner, preferably wood lagging with Russia iron covering.

30. Lubrication.—Provision to be made for ample and efficient lubrication of all working parts throughout. The cylinders of propelling engines and of main driving engines to have patent sight-feed oil feeders, one quart capacity, of best pattern. Cylinders of electric-light engine and condenser pump and of auxiliary engines to have similar oil feeders of one pint capacity. Crank-shaft bearings of engines, crank-pin bearings, pump bearings, slides of engines, and other important bearings where compression grease cups are not used, to have drop-sight feed oilers. Important slow-running bearings not readily accessible, or those exposed to grit and dirt, to have compression grease cups. In general, bearings not otherwise provided for to have oil or grease cups with covers. Provision to be made to recover oil drippings from principal bearings.

Necessary oil cans and oilers, and one oil tank of ample capacity to be provided.

31. Blow-offs, drips, etc.—All blow-off and discharge-pipes to be led outboard. All drips from pet cocks, gauge cocks, or drains to be piped and led outboard to hold, or discharge arranged otherwise so as not to be objectionable.

32. Steam coils.—Steam heaters or coils to be provided in rooms on upper deck and pilot house with all proper steam and discharge connections. Steam pipes and connections to be provided for heating water in bathroom and kitchen.

33. Steam whistle.—A steam whistle about 6 inches in diameter to be mounted at proper height between the main smoke pipes, with connections for operating from pilot house.

34. Tools.—The workshop (after engine room) to be provided with bench, vise, portable forge of large size, anvil, hand-power drilling machine, and supply of black-

smiths' and machinists' tools suitable for making ordinary repairs on board. The outfit will include a set of bolt taps and dies from ⅜ inch to 1½ inch; a set of pipe dies from ¼ inch to 3 inch, with taps from ¼ inch to 2 inches; and pipe vise and tongs to suit.

35. Spare pieces.—The following spare parts of foregoing machinery will be supplied, all fitted and ready for use:

1 set of blades of dredging pump.
1 set of linings for dredging pump.
6 blades for cutter.
6 center and 12 side links for driving chain.
12 pins for driving chain.
1 lifting cam for spud anchor.
1 set grate bars for main boiler furnaces.
1 set grate bars for auxiliary boiler furnace.
1 set complete of fire door liners.

36. Defective work.—No defective casting, forging, or other work, and no defective material of any kind is to be accepted in the dredging plant.

37. Approval of details.—All important details not yet determined upon and all principal detail drawings and descriptions of work not yet clearly specified in full detail are to be submitted to the party of the first part, and are to be subject to his approval.

38. Modifications.—While it is the intent of these specifications to give dimensions and descriptions of all portions of the plant as nearly as practicable with present information, it is understood that such modifications of dimensions or minor details as it may be found necessary or expedient to make in order to carry out the intent of the contract shall be made upon mutual agreement, provided the cost of the plant to the Government is not increased and its value and efficiency not impaired.

39. In general.—It is understood that the party of the second part will supply the foregoing dredge and all the machinery in connection therewith, together with all the furnishing and equipments necessary for the efficient working of same, and will submit any and all parts to inspection during construction, and will furnish all the information necessary for that purpose. They also engage to deliver the dredge at her destination, in the Fourth District, Mississippi River, and will there to put her in working order and to furnish the services of a skilled man to superintend the running of machinery until the dredge is in successful operation and has run satisfactorily during a test period of not less than ten days continuously. And the said parties of the second part hereby guarantee the material and workmanship will be thoroughly sound and first class throughout, failing which, they further agree to replace and make good any defects which may develop upon the trial of the machinery.

The parties of the second part guarantee the U. S. Government against any claims that may be made for the use of any patented device whatever furnished by it, and will hold the said Government harmless from any such claims. It is understood, however, that the parties of the second part do not agree to supply any stores or any material subject to consumption, except as herein specified, nor any further labor required for the handling or the working of the dredge after her arrival at her aforesaid destination except the superintendent before named."

While not new in principle the dredge has several features and combinations which are novel. It is a well built-machine throughout and will, it is believed, prove an efficient and economical apparatus for the services for which she was designed.

The lowest reading of the gauge at Barbres Landing was eight-tenths feet above zero on November 8. The least channel depth in Old River reported was 6 feet. This was sufficient for the light-draft boats which were enabled to navigate the rivers having their outlets through Lower Old River, and navigation through Lower Old River was therefore maintained during the low-water season.

Considerable erosion and caving having taken place near the east end of the Red River Dam and about the east end of the upper sill dam in the Atchafalaya, repairs were made during March. The work consisted in depositing rock taken from that stored on Turnbulls Island near the ends of the dams. Five hundred tons were placed on the lower side of the Red River Dam, 921 tons on lower side of the Upper Atchafalaya Dam, and 521 tons on the upper side of this dam. The cost of this work was $113.30.

During March and April the telephone line between Barbres Landing and West Melville was repaired and rebuilt and the line was also extended out to Red River Landing on the Mississippi, a distance of about 7 miles. Sawed cypress poles were substituted for the round pine poles first put up, which had become much decayed.

The repairs and enlargement of the levee, connecting the spur levees at the ends of the Atchafalaya sill dams on the Simmesport side, were completed under contract at a cost of $77.79.

Money statement.

June 1, 1893, balance unexpended	$139,973.00
May 31, 1894, amount expended during fiscal year	96,674.21
May 31, 1894, balance unexpended	43,298.79
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867, and of sundry civil act of March 3, 1893.	350,000.00

NEW ORLEANS HARBOR.

The general object of the works of improvement in New Orleans Harbor is to check and if possible to prevent the detrimental action of the river in eroding the banks and to maintain the river banks in a condition of permanency.

Under the approved project the work to accomplish these objects consists in the construction of submerged inclined spur dikes along the caving banks, which extend out normally to the bank line and which have heretofore been placed at intervals of from 500 to 1,600 feet.

In addition to these dikes continuous bank revetment has been constructed in the intervals where the destructive forces have proved very active. This revetment has an average width of about 400 feet and extends from low-water line out to deep water, covering the entire bank slopes. In building this revetment mattresses made of willow brush and poles and fastened with sawed timber and wire are first constructed in sections of convenient size and about 2 feet thick. These sections are then fastened together, forming a large mattress, which has a width of 130 to 150 feet and a length equal to the width of the revetment. This mattress is floated to position between lines of barges secured by mooring lines, and is sunk by loading it with rock evenly distributed over its surface. After it is sunk additional rock is deposited on it. The spur dikes are built of successive layers of mattresses of diminishing width, constructed in a manner similar to that above described, except that they are made two or three times as thick, and the willows are so laid as to leave square "pockets" to receive and retain the rock. These mattresses or cribs are so designed that the top of the completed dike has a width of about 16 feet and a slope in the direction of the length of the dike of about 3 base to 1 perpendicular. Various side slopes have been given to the dikes, from 1 base to 1 perpendicular to 2 base to 1 perpendicular, the latter slope being now preferred. When the intervals have not been continuously revetted the dike rests on a foot mattress about 150 feet wide. In places in the harbor where the water front is required for docks the crest of the dike at the shore end is kept below the draft of vessels; at other localities the crest has been carried up to low-water line and continued up to the main levee by a spur levee built of earth and paved with rock.

The design is to begin sinking the mattresses during the end of the low-water season, but this has not always been practicable, and some of the work has been placed in comparatively high stages.

The effect which the continuous revetment is intended to produce is to cover the entire bank slope directly after the caving for the season has ceased and when the bank has presumably a form best adapted to stability and to protect it from further erosion. Spur dikes without intermediate revetment have been successful in some of the straight reaches and on concave banks of large radius, but in the abrupt bends the dikes alone are only locally effective.

At the date of the last annual report the following work had been completed in general accordance with the project as above outlined: A continuous mattress 400 feet in length had been placed just above the caving bank in the Carrollton Bend. Five spur dikes with continuous revetment, covering the three upper intervals and somewhat more than one-third of the lower one, had been built in the Carrollton Bend, two spur dikes in the Greenville Bend, six in the Gouldsboro Bend, and eight in the Third District Reach.

All of the above work remains in place and has proved successful, with the following exceptions: In the Third District Reach no further caving took place at the heads of the dikes, but caving continued, more or less serious in extent, in the intervals between the dikes, and there has been no noticeable accretion. In this locality the intervals between dikes are evidently too great, and the intervals should be protected with continuous revetments.

In the Gouldsboro Bend a small cave has occurred between Dikes 3 and 4, but otherwise the bank line has remained unchanged.

In the Carrollton Bend serious caving continued in the intervals between dikes

before the continuous revetment was put down. Since the completion of this work there has been no further caving.

Destructive caving has also taken place along the water front between Carrollton and Exposition wharf, at Eighth street, at the Soraparu market, in the bend at and below the French market, and at Algiers Point. No protection work has been done at these localities by the United States, but the city of New Orleans has constructed pile work and wooden bulkheads with a view to arresting the caving near the French market, at Algiers Point, and in the intervals between the Third District spur dikes. This work has been partially successful, except in the Third District Reach.

No construction work has been in progress during the past season, owing to the funds being exhausted. The destructive action of the river continues in several localities in the harbor where protection work has not yet been done.

LEVEES.

For works connected with levee construction and maintenance the district is subdivided into six levee districts, as follows:

The Lower Tensas levee district, right bank, which extends from the upper limits of the Fourth District, opposite Warrenton, to the mouth of Red River, and comprises 157½ miles of the Mississippi River. In this district the levee system is continuous from the upper end down to a point 5 miles below Fairview Landing, a length of 130.5 miles of the river, leaving about 26 miles of river on this bank unleveed.

The Atchafalaya levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system in this district is continuous.

The Barataria levee district, right bank, which extends from New Orleans to the Head of the Passes, 102.5 miles. The levee system is practically continuous down to the Jump, an opening through the bank of the main river about 10 miles above the Head of the Passes. In the lower parts of the district, however, the strip of cultivated land is narrow and the variations in the height of the river become comparatively slight and the levees are small affairs. The total length of river covered by levees is 91.5 miles.

The Lafourche levee district, right bank, which extends from the head of Bayou Lafourche to New Orleans. The distance by river is 71 miles, and the levee system is continuous.

The Pontchartrain levee district, left bank, which extends from New Orleans to Baton Rouge. It comprises 123.5 miles of the river, and the levees are continuous.

The Lake Borgne levee district, left bank, which extends from New Orleans to the Head of the Passes, 102.5 miles. The levee system only extends at present to Fort Jackson, covering 82 miles of the river, and the same remarks concerning the lower portion of the Barataria levee district apply to corresponding parts of the Lake Borgne levee district.

Between Warrenton and Baton Rouge the river follows the general direction of the bluff line on the left bank, being at no point at any great distance from the high land. Numerous detached private levees exist along this portion of the river, which are more or less efficient, and which are designed solely for the local purpose of protecting the cultivated bottom lands between the river and the bluffs from overflow.

Assistants have been in local charge of levee districts during the year as follows:

Assistant Engineer H. S. Douglas, in charge of the Lower Tensas levee district, in addition to his duties in charge of the work of improvement of the harbors of Natchez and Vidalia, and of certain gauges.

Assistant Engineer W. J. Hardee, in charge of the Atchafalaya, Lafourche, and Pontchartrain levee districts.

Assistant Engineer John Smyth, jr., in charge of the Barataria and Lake Borgne levee districts.

Up to the date of the last annual report levee construction and extensive repairs had been done by the Federal Government in the fourth district at the following-named points:

Name of levee and levee district.	Bank.	Below Cairo.	Year.	Name of levee and levee district.	Bank.	Below Cairo.	Year.
Lower Tensas levee district:		*Miles.*		Lower Tensas levee district—Continued.			
Bedford	R.	606.5	1891	Ships Bayou to Hard Times	R.	*Miles.* 633	1885
Point Pleasant	R.	624	1883	Evergreen	R.	637	1885
Do	R.	624	1886	Hardscrabble	R.	639	1882
Hard Times to Wilson.	R.	631	1890	Hardscrabble and Bondurant	R.	640	1881
Ships Bayou to Hard Times	R.	633	1884				

Name of levee and levee district.	Bank.	Below Cairo.	Year.
Lower Tensas levee district—Continued.		*Miles.*	
Hardscrabble Lower	R.	640.4	1893
Bondurant	R.	643.5	1893
Kempe	R.	658	1885
Do	R.	658	1888
Do	R.	659	1891
Do	R.	659	1892
Gibsons	R.	683.5	1891
Lake Concordia	R.	694	1883
Do	R.	694	1885
Ferriday	R.	694	1885
Do	R.	694	1891
Ferriday Break	R.	694	1892
Wiccema to Fletcher	R.	698	1893
Arnauldia	R.	702	1891
Morville	R.	710	1893
Hendersons	R.	713	1891
Greens to Fairview	R.	720	1884
Deer Park	R.	722.5	1887
Do	R.	722.5	1891
Fish Pond	R.	732	1893
Atchafalaya levee district:			
Atchafalaya to Red River	R.	765	1883
Hog Point to Raccourci	R.	767	1883
Raccourci Crevasse	R.	775	1883
Morganza	R.	789	1887
Stewarts	R.	791	1883
Nina	R.	806.5	1891
Highland Extension	R.	815.5	1892
Highland	R.	815.7	1891
Barroza Upper	R	823	1893
Barroza Middle	R.	823	1893
Barroza	R.	824	1891
Belair	R.	828	1893
Eliza	R.	842	1893
Medora	R.	852	1893
Mayflower-Union	R.	853	1892
Fortville	R.	855	1892
Fortville Lower	R.	855	1893
Evergreen	R.	857	1891
Dunboyne	R.	865	1892
Lafourche levee district:			
Buena Vista-Minnie	R.	896	1893
Jamestown	R.	897	1893
St. James Church	R.	901	1893
St. James estate	R.	902.5	1893
Home Place	R.	905.5	1893
Lone Star	R.	941.5	1893
Davis	R.	943	1893
Barataria levee district:			
Magnolia	R.	980.5	1893
Fort St. Leon Upper	R.	981.5	1893
Fort St. Leon Lower	R.	982.5	1893
Belle Chasse Crevasse	R.	983	1893
Belle Chasse to Concession	R.	985	1893
Concord	R.	987	1893
Barataria levee district—Continued.		*Miles.*	
Oak Point	R.	988.5	1893
Live Oak	R.	991.5	1893
Happy Point	R.	994	1893
Pontchartrain levee district:			
Shannon	L.	837	1891
Martinez	L.	842	1891
Lopez	L.	844.5	1893
Gay to Hollywood	L.	845	1891
Burtville	L.	847	1893
Woodstock	L.	847.5	1891
Hermitage	L.	850	1891
Towles	L.	851	1893
Billings	L.	852.3	1893
Grenada to Mount Olive	L.	855.5	1891
Jolisant	L.	858.8	1893
Oakly to St. Gabriel	L.	862	1893
Southwood Extension	L.	875.5	1892
Do	L.	875.5	1891
Ashland to Linwood	L.	878	1891
Dicharry	L.	882	1891
Dicharry Lower	L.	883	1893
Burnside	L.	891	1893
Irvine	L.	892.5	1891
Union Upper	L.	893	1893
Union Lower	L.	893	1893
Union	L.	893.5	1891
Tippecanoe	L.	894	1893
Poytavin	L.	894.5	1893
Whitehall	L.	895	1893
Lilly	L.	900.5	1891
College Point to St. Michael	L.	903.5	1890
Tessier-Bourgeois	L.	909.5	1892
Tessier	L.	909.5	1893
Hope	L.	916.5	1893
Terre Haute to Hope	L.	919.5	1891
Cornland	L.	922	1891
Destrahan	L.	939	1891
Frellson to Almedia	L.	942	1891
Trudeau	L.	949	1893
Southport	L.	955.5	1892
Lake Borgne levee district:			
Slaughter House	L.	968.5	1893
Slaughter House Extension	L.	968.5	1893
Roy	L.	969	1893
Bonzano	L.	969	1893
Chalmette Cemetery	L.	969.5	1893
Deboushel	L.	970	1893
Pecan Grove	L.	973	1893
Story Upper	L.	974	1893
Story Lower	L.	975	1893
Repose	L.	976	1893
Caernarvon	L.	979	1893
Orange Grove Upper	L.	980	1893
Orange Grove Lower	L.	980	1893

The foregoing does not include work of minor repairs done to assist in protecting and maintaining the levees during high water.

Under the authority of the act of July 13, 1892, allotments have been made by the Commission as follows for the several levee districts under charge of this office:

Allotments from appropriation for fiscal year 1893-'94.

Lower Tensas levee district	$132,000
Atchafalaya levee district	152,000
Lafourche levee district	90,000
Barataria levee district	60,000
Pontchartrain levee district	150,000
Lake Borgne levee district	50,000

In accordance with the resolution of the Commission of August 4, 1892, contracts had been made and considerable work done at the date of the last annual report under the allotment for the fiscal year ending June 30, 1894. Few of these contracts had been completed, however, and the details of this work as well as of that contracted for during the past year are given in the following tables:

Fourth district levees, 1893–'94.

LOWER TENSAS AND ATCHAFALAYA LEVEE DISTRICTS.

Name of levee.	Below Cairo.	Bank.	Contractor.	Length of line.
Lower Tensas levee district:	*Miles.*			*Feet.*
Videl	615	R.	Garbish & O'Neil	7,920
Davis Island	622	R.	J. S. McTighe & Co	11,616
Hard Times-Wilson	632	R.	R. T. Martin & Co	14,080
Hardscrabble	643	R.	Charles T. Worthington	9,240
Bondurant	644	R.	Edwin B. Helgason	5,808
Cottage Home	649	R.	do	2,464
Rifle Point	690	R.	J. S. McTighe & Co	18,304
Grassmere to Wiccema	693	R.	McLaughlin Bros	31,680
Fletcher to Minorca	699	R.	Rutherford & Dalgarn	14,256
Minorca to Minors	702	R.	Albert H. Gillespie	17,776
Lake Concordia	695	R.	do	4,752
Morville to Greens	715	R.	J. A. Carson	36,960
Forest Home	723	R.	Manning & Gibson	7,392
Glasscock	726	R.	L. M. Dalgarn	23,760
Atchafalaya levee district:				
Torras	766	R.	G. W. Reagan	1,320
Fleta	786	R.	R. M. Quigley & Co	2,376
Provosty	796	R.	Hartnett & O'Brien	4,224
St. Francis Church	798	R.	Manning & Gibson	1,584
Belle Vale	825.5	R.	W. J. Bentley & Co	2,640
Homestead	832	R.	John Appel	660
Port Allen	832.5	R.	John Scott & Sons	4,356
Missouri	840	R.	do	4,224
Nereaux	851	R.	do	4,752
Rebecca	857	R.	do	4,224
Golden Ridge	861.5	R.	Michael Hanick	1,452
Dunboine Upper	865	R.	George M. D. Grigsby	2,112
Harroll	866	R.	J. S. McTighe & Co	2,112
Dorcyville	868.5	R.	John Scott & Sons	1,320
Belle Grove	870	R.	George M. D. Grigsby	4,752
Celeste	871.5	R.	W. L. Killebrew	2,904
Mount Salem	872	R.	do	2,376
Babin	879	R.	Jeffries & Dameron	1,452

Name of levee.	Length of axis of river covered.	Grade of levee above high water, 1893.	Section.		
			Crown.	River slope.	Land slope.
Lower Tensas levee district:	*Feet.*	*Feet.*	*Feet.*		
Videl	6,000	3	8	3 to 1	2½ to 1.
Davis Island		2½	6 and 8	3 & 2½ 1	Do.
Hard Times-Wilson	10,000		8	1	3 to 1.
Hardscrabble	13,000	2½	8	3 1	2½ to 1.
Bondurant	5,300	2½	8	3 1	Do.
Cottage Home	2,400	2½	8	3 1	2½ and 4 to 1.
Rifle Point	30,000	2½	8	3 1	2½ to 1.
Grassmere to Wiccema	5,500	2½	8	3 1	Do.
Fletcher to Minorca	1,200	2½	8	3 1	Do.
Minorca to Minors	14,000	2½	8	3 1	Do.
Lake Concordia	3,000	2½	8	3 1	Do.
Morville to Greens	55,000	2½	8	3 1	2½ and 4 to 1.
Forest Home	5,000	2½	8	3 1	Do.
Glasscock	20,000	2½	4	1½ 1	1½ to 1
Atchafalaya levee district:					
Torras	1,220	2½	8	3 1	
Fleta	2,365	2½	8	3 1	2.5, 4, and 6 to 1.
Provosty	4,124	2½	8	3 1	2½ and 4 to 1.
St. Francis Church	1,790	2½	8	3 1	Do.
Belle Vale	3,200	2½	8	3 1	Do.
Homestead	570	2½	8	3 1	Do.
Port Allen	4,120	2½	8	3 1	Do.
Missouri	4,210	2½	8	3 1	Do.
Nereaux	4,200	2½	8	3 1	Do.
Rebecca	4,380	2½	8	3 1	Do.
Golden Ridge	1,380	2½	8	3 1	2½ to 1.
Dunboine Upper	2,630	2½	8	3 1	2½ and 4 to 1.
Harroll	2,510	2½	8	3 1	Do.
Dorcyville	820	2½	8	3 1	Do.
Belle Grove	4,000	2½	8	3 1	Do.
Celeste	2,730	2½	8	3 1	2½ to 1.
Mount Salem	1,920	2½	8	3 1	Do.
Babin	1,420	2½	8	3 1	Do.

Fourth district levees, 1893-'94—Continued.

LOWER TENSAS AND ATCHAFALAYA LEVEE DISTRICTS—Continued.

Name of levee.	Net fill. Least.	Net fill. Greatest.	Net fill. Average.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavations. Cubic yards.	Filled excavations. Price per cubic yard.
Lower Tensas levee district:	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*
Videl	5.6	11.4	8	25,768.65	13⅜	1,270	13⅜
Davis Island	5.5	17.5	8	25,351.50	13.45	27.30	13.45
Hard Times, Wilson				64,729.13	18.73	3,477.77	18.73
Hardscrabble	6.2	12	9.5	24,399.01	19	891	19
Bondurant	6.7	18.8	9	12,367.12	14.43	42.70	14.43
Cottage Home	7.8	12.8	9.7	34,179.25	12.75		
Rifle Point	3.6	9.2	6	63,280.99	15.94	3,053.30	15.94
Grassmere to Wiccema	4.8	20.5	6	108,205.45	17½	206.03	16
Fletcher to Minorca	5.6	16.7	7	117,789.84	15.4	1,077	15.4
Minorca to Minors	4.7	14.8	6.5	85,244.40	14	584.72	13.50
Lake Concordia	6.6	9.7	7	38,324.70	10.7	12.07	10.7
Morville to Greens	5	14.2	10	55,508.49	29½	3,779.27	29½
Forest Home	6.5	13.8	10	99,580.32	10	3,169.20	10
Glasscock	6	13.6	11	13,438.53	19		
Atchafalaya levee district:							
Torras	4.2	12.6	9.3	13,967.28	12½	209.25	15
Fleta	.6	17.8	16.8	100,702.23	15.74	482.40	15.74
Provosty	.7	22	14	97,438.88	14	704.82	14
St. Francis Church	.5	13.1	11	32,428.25	15	46.11	15
Belle Vale	.4	14	12.4	71,524.85	16⅔	55.06	13
Homestead	2.2	11.9	10.8	10,196.98	11⅓		11⅓
Port Allen	1.9	14	12.5	93,347.17	12.93	184.09	10
Missouri	.8	13.7	12.9	108,816.38	16.99	88.04	16.99
Nereaux	1.8	13.2	11.3	78,258.12	12.93	353.86	10
Rebecca	1.1	15.7	12.6	85,212.61	16.74		16.74
Golden Ridge	1.1	10.6	9.8	18,786.80	12	284.32	12
Dunboine Upper	1.1	12.2	10.7	45,112.82	14.73	553.85	14½
Harroll	1.1	12.3	10.8	45,573.32	12.99	132.84	12.99
Dorcyville	1	12.9	13.4	28,529.60	14	108.34	10
Belle Grove	1.4	11	10.5	64,029.27	14.73	1,077.43	14½
Celeste	8	10.9	9.7	36,639.79	14.99	52.81	
Mount Salem	.7	10.9	9.1	25,764.48	14.94	14.20	14
Babin	.7	10.8	9.4	19,764.43	15	22.38	15

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Work commenced.	Work completed.
Lower Tensas levee district:	*Lin. ft.*				
Videl		Nov. 8, 1893	Feb. 15, 1894	Nov. 27, 1893	Feb. 28, 1894
Davis Island		Sept. 18, 1893	....do	Sept. 25, 1893	Nov. 27, 1893
Hard Times, Wilson		Nov. 8, 1893	....do	Nov. 7, 1893	Apr. 3, 1894
Hardscrabble		Sept. 18, 1893	....do	Oct. 2, 1893	Dec. 29, 1893
Bondurant		....do	....do	Oct. 3, 1893	Dec. 16, 1893
Cottage Home	350	....do	....do	Sept. 25, 1893	Nov. 17, 1893
Rifle Point	1,459	Feb. 6, 1893	June 30, 1894	Sept. 21, 1893	Feb. 17, 1894
Grassmere to Wiccema	194	Nov. 9, 1892	Feb. 15, 1893	Nov. 3, 1892	Aug. 3, 1893
Fletcher to Minorca	3,059	Nov. 14, 1892	Mar. 1, 1893	Nov. 14, 1892	July 21, 1893
Minorca to Minors	1,244	....do	....do	Nov. 15, 1892	July 31, 1893
Lake Concordia	2,008	Jan. 2, 1894	Feb. 15, 1894	Oct. 2, 1893	Mar. 3, 1894
Morville to Greens		Sept. 18, 1893	Mar. 15, 1894	Feb. 12, 1894	Apr. 27, 1894
Forest Home		Jan. 20, 1894	....do	Jan. 8, 1894	May 9, 1894
Glasscocks		Nov. 8, 1893	Feb. 15, 1894	Nov. 6, 1893	Mar. 2, 1894
Atchafalaya levee district:					
Torras		....do	Jan. 1, 1894	Nov. 22, 1893	Jan. 7, 1894
Fleta	484	Sept. 23, 1893	Mar. 1, 1894	Nov. 6, 1893	Dec. 10, 1893
Provosty	1,250	....do	Feb. 15, 1894	Sept. 26, 1893	Mar. 7, 1894
St. Francis Church		Feb. 7, 1893	June 30, 1894	Nov. 6, 1893	Feb. 10, 1894
Belle Vale	34.37	Feb. 6, 1893	....do	Apr. 10, 1893	Oct. 4, 1893
Homestead		Dec. 5, 1893	Jan. 1, 1894	Dec. 5, 1893	Jan. 14, 1894
Port Allen		Jan. 17, 1894	Mar. 1, 1894	Nov. 27, 1893	Mar. 15, 1894
Missouri		Feb. 7, 1894	June 30, 1894	Apr. 7, 1893	Sept. 29, 1893
Nereaux		Nov. 8, 1893	Mar. 11, 1894	Nov. 2, 1893	Mar. 10, 1894
Rebecca	233.33	July 10, 1893	June 30, 1894	Sept. 11, 1893	Jan. 28, 1894
Golden Ridge		Sept. 23, 1893	Feb. 15, 1894	Dec. 23, 1893	Feb. 2, 1894
Dunboine Upper		Feb. 7, 1894	June 30, 1894	July 13, 1893	Sept. 16, 1893
Harroll		Sept. 23, 1893	Feb. 15, 1894	Sept. 28, 1893	Jan. 19, 1894
Dorcyville			Feb. 1, 1894	Nov. 2, 1893	Feb. 6, 1894
Belle Grove		Feb. 7, 1894	June 30, 1894	Sept. 2, 1893	Feb. 14, 1894
Celeste		....do	....do	Mar. 18, 1893	Oct. 7, 1893
Mount Salem		....do	....do	Mar. 22, 1893	Sept. 25, 1893
Babin		....do	....do	Nov. 20, 1893	Jan. 31, 1894

Fourth district levees, 1893–'94—Continued.

LOWER TENSAS AND ATCHAFALAYA LEVEE DISTRICTS—Continued.

Name of levee.	Distance from center of levee to river bank.			Nature of river bank.	Extension granted to—	Remarks.
	Least.	Greatest.	Average.			
Lower Tensas levee district:	*Feet.*	*Feet.*	*Feet.*		1894.	
Videl	21,000	21,000	21,000	Permanent	Feb. 25	Enlargement.
Davis Island	4,000	6,000	5,000	Not caving		Do.
Hard Times–Wilson.	2,400	11,700	7,000	Caving slowly	Apr. 3	Enlargement did not affect original crown width or land slope.
Hardscrabble	800	4,500	2,600	Permanent, not caving		Enlargement.
Bondurant	200	1,700	950	Caving slowly		Do.
Cottage Home	750	950	850	Caving rapidly		New levee.
Rifle Point	2,100	10,000	6,000	Permanent, no cave		New and enlargement.
Grassmere to Wicema.	2,200	16,000	16,000	Permanent, on lake	Aug. 15	Enlargement.
Fletcher to Minorca.	2,000	12,000	7,000	Caving rapidly	June 30	New and enlargement.
Minorca to Minors.	800	6,000	3,400	Caving slowly	June 30	Do.
Lake Concordia	2,000	4,000	3,000	Caving rapidly		Do.
Morville to Greens.	200	15,000	1,000	Permanent, no cave	Apr. 26	Enlargement.
Forest Home	2,500	3,000	2,750	Caving rapidly	May 15	New levee, not effective yet.
Glasscock	600	2,200	1,400	Caving slowly	Mar. 1	Enlargement.
Atchafalaya levee district:						
Torras	190	255	215	do		New.
Fleta	385	920	780	Caving rapidly		Do.
Provosty	680	1,140	1,085	do	Mar. 15	Do.
St. Francis Church.	175	755	565	Caving slowly		Do.
Belle Vale	220	450	325	do		Do.
Homestead	145	340	195	do	Feb. 1	Do.
Port Allen	190	440	310	Caving (periodical)	Mar. 15	Do.
Missouri	215	735	490	do		Do.
Nereaux	235	580	480	Caving		Do.
Rebecca	395	745	625	Caving upper end		Do.
Golden Ridge	75	215	180	Washing		Do.
Dunboine Upper	215	455	380	Washing and caving		Do.
Harroll	175	145	385	Caving slowly		Do.
Dorcyville	300	675	530	Rapid caving		Do.
Belle Grove	128	406	360	Caving and washing		Do.
Celeste	115	486	365	do		Do.
Mount Salem	204	445	385	do		Do.
Babin	185	342	285	Caving (periodical)		Do.

Fourth district levee revetment, 1893–'94.

LOWER TENSAS LEVEE DISTRICT.

Lake Concordia levee revetment.—Miles below Cairo, 695 R; contractor, Andrews Bros. Construction Company; length 11,562 linear feet; price per linear foot, 66 cents; contract time for completion, March 1, 1894; date of contract, January 2, 1894; work commenced, January 11, 1894; extension of time granted to March 10, 1894; work completed, March 15, 1894.

Fourth district levees, 1893-'94—Continued.

PONTCHARTRAIN AND LAFOURCHE LEVEE DISTRICTS.

Name of levee.	Below Cairo.	Bank.	Contractor.	Length of line.
Pontchartrain levee district:	*Miles.*			*Feet.*
Shannon Lower	837	L.	Manoah V. Henry	6,056
Conrad	843	L.	Mike Kane	2,228
Ben Hur	845	L.	T. W. Scott	4,586
Plaquemine Point	853	L.	....do	4,762
Maryland	872	L.	Alexander Eltringham	4,570
Hard Times	873	L.	G. B. Edwards	2,045
Rescue No. 1	874	L.	Alexander Eltringham	1,061
Southwood Upper	874.7	L.	....do	1,670
Rescue No. 2	875	L.	Michael Hanick	2,014
Bello Helene	879	L.	Rutherford & Dalgarn	3,544
Houmas	891	L.	Alexander Eltringham	2,266
College Point	905	L.	Donovan, Daley & Co	4,944
Hester	908.5	L.	S. D. Moody & Co., Limited	5,466
St. Elmo	910	L.	....do	1,812
Poche	911	L.	Jeffries & Dameron	2,521
Terre Hauto	921	L.	H. C. Brown	4,337
Reserve	922	L.	The Eltringham Construction Co	649
Prospect	936	L.	Homan, McFadden, & Cassidy	2,360
Trudeau	949	L.	Thomas O'Malley	2,000
Lafourche levee district:				
Home Place (1892-'93)	905.5	R.	Homan, McFadden, & Cassidy	3,482
Melancon-Lemanville	893	R.	Ovide Lacour	5,819
Brookstown	897	R.	Hayes Bros	2,775
Jamestown Lower	898	R.	Ovide Lacour	2,260
St. Emma	904	R.	Charles T. Worthington	3,449
Magnolia	911	R.	E. W. Hanlon & Co	2,856
White Rose	918	R.	Jeffries & Dameron	1,623
Providence	932	R.	Geo. M. D. Grigsby	2,650
Waterford	932	R.	Hayes Bros	3,151
Flagtown	936.5	R.	Andrews Bros. Construction Co	1,953
Speranza	937	R.	....do	2,220
Ashton	940	R.	Geo. M. D. Grigsby	2,341
Coopersville	944	R.	Andrews Bros. Construction Co	2,800

Fourth district levees, 1893-'94—Continued.

PONTCHARTRAIN AND LAFOURCHE LEVEE DISTRICTS—Continued.

Name of levee.	Length of axis of river covered.	Grade of levee above high water, 1893.	Section.		
			Crown.	River slope.	Land slope.
Pontchartrain levee district:	*Feet.*	*Feet.*	*Feet.*		
Shannon Lower	5,700	2.5	8	3 to 1	2½ and 4 to 1.
Conrad	2,410	2.5	8	3 1	2½ to 1.
Ben Hur	4,260	2.5	8	3 1	2½ and 4 to 1.
Plaquemine Point	10,140	2.5	8	3 1	2½ to 1.
Maryland	4,180	2.5	8	3 1	Do.
Hard Times	2,040	2.5	8	3 1	2½ and 4 to 1.
Rescue No. 1	730	2.5	8	3 1	Do.
Southwood Upper	1,480	2.5	8	3 1	Do.
Rescue No. 2	1,900	2.5	8	3 1	Do.
Belle Helene	3,100	2.5	8	3 1	Do.
Houmas	1,650	2.5	8	3 1	2½ to 1.
College Point	5,950	2.5	8	3 1	Do.
Hester	5,100	2.5	8	3 1	2½ and 4 to 1.
St. Elmo	3,275	2.5	8	3 1	Do.
Poche	2,710	2.5	8	3 1	2½ to 1.
Terre Haute	4,100	2.5	8	3 1	Do.
Reserve	700	2.5	8	3 1	2½ and 4 to 1.
Prospect	1,050	2.5	8	3 1	Do.
Trudeau	2,400	2.5	8	3 1	Do.
Lafourche levee district:					
Home Place (1892-'93)	3,380	2.5	8	3 1	Do.
Melancon-Lemanville	5,475	2.5	8	3 1	2½ to 1.
Brookstown	2,540	2.5	8	3 1	2½ and 4 to 1.
Jamestown Lower	2,152	2.5	8	3 1	Do.
St. Emma	3,270	2.5	8	3 1	2½ to 1.
Magnolia	2,700	2.5	8	3 1	Do.
White Rose	1,775	2.5	8	3 1	Do.
Providence	2,380	2.5	8	3 1	Do.
Waterford	2,950	2.5	8	3 1	Do.
Flagtown	1,760	2.5	8	3 1	Do.
Speranza	2,130	2.5	8	3 1	2½ and 4 to 1.
Ashton	2,178	2.5	8	3 1	Do.
Coopersville	2,670	2.5	8	3 1	Do.

Name of levee.	Net fill.			Embankment.		Filled excavations.	
	Least.	Greatest.	Average.	Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.
Pontchartrain levee district:	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*
Shannon Lower	.6	12.9	11.1	105,831.53	15	210.50	13
Conrad	.9	9.7	8.5	24,407.20	11.99	384	.....
Ben Hur	1.8	12.3	10.9	72,723.03	11.40	67.81	11.40
Plaquemine Point	2.2	9.6	5.5	31,132.22	10.40	141.42	10.40
Maryland	4.8	10.9	10.4	62,644.57	14.73	280.13	14.73
Hard Times	2.3	11.5	10.8	31,216.74	11.94	444.72	11.94
Rescue No. 1	4	14.7	13.8	25,449.88	15	15.26	15
Southwood Upper	2.4	12.9	12.3	34,316.23	15.43	17.15	14
Rescue No. 2	4	15.2	13.8	49,661.63	13½	189.13	13½
Belle Helene	1.2	15.3	10.5	59,555.57	16.40	493.20	15
Houmas	2	9.8	9.1	23,318.12	15.43	.....	14
College Point	1.6	11.3	9	52,741.98	10.40	812.24	16
Hester	.7	14.4	13.1	122,402.29	15½	209.85	15½
St. Elmo	4	12.1	11.3	32,581.96	15¾	2	15¾
Poche	1.3	8.8	8.4	24,789.41	15	123.69	15
Terre Haute	.8	10	9	48,430.11	14.90	333.39	10
Reserve	1.8	13	10.7	10,488.84	12.23	.....	10
Prospect	2.8	12.05	12.5	48,269.90	16	83.38	16
Trudeau	.3	11.3	11.3	39,760.98	14	256.06	14
Lafourche levee district:							
Home Place	.9	13.4	11.5	63,653.78	18.45	1,443.74	18.45
Melancon-Lemanville	2.1	11	9.4	63,444.46	14	368.70	10
Brookstown	2.2	14.9	12.1	61,252.71	13.45	384.34	13.45
Jamestown Lower	1	12.4	11.6	41,888.62	14.95	234.42	10
St. Emma	.2	11.3	9.7	45,690.12	14½	222.50	14
Magnolia	1.4	17.1	10	37,857.39	14.49	386.82	13
White Rose	.7	13.3	9.5	19,195.63	15	220.56	15
Providence	.4	11.2	9.8	38,252.11	14.77	142.29	14.77
Waterford	.4	11.3	9.8	42,138.93	13	274.94	13
Flagtown	3.2	9	7.3	16,230.76	14.94	51.06	14.94
Speranza	.3	12.1	10.3	33,064.40	14.74	.....	14.74
Ashton	2.1	12.6	10.6	38,120.95	14.77	184.51	14.77
Coopersville	1.7	11.7	10.7	45,311.58	12.92	143.57	12.92

Fourth district levees, 1893-'94—Continued.

PONTCHARTRAIN AND LAFOURCHE LEVEE DISTRICTS—Continued.

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Work commenced.	Work completed.
Pontchartrain levee district:	*Lin. ft.*				
Shannon Lower	66.66	Feb. 7, 1893	June 30, 1894	Nov. 6, 1893	Feb. 16, 1894
Conrad	.....	Sept. 23, 1893	Jan. 1, 1894	Sept. 25, 1893	Nov. 13, 1893
Ben Hur	.....	Sept. 28, 1893	Mar. 1, 1894	Oct, 2. 1893	.....
Plaquemine Point	.....	....do	Feb. 15, 1894	Oct. 20, 1893	Jan. 24, 1894
Maryland	.....	Feb. 7, 1893	June 30, 1894	May 8, 1893	Feb. 17, 1894
Hard times	46.66	Sept. 28, 1893	Feb. 15, 1894	Oct. 12, 1893	Dec. 27, 1893
Rescue No. 1	.....	Feb. 7, 1893	June 30, 1894	May 11, 1893	Nov. 20, 1893
Southwood Upper	.....	....do	....do	Sept. 16, 1893	Dec. 26, 1893
Rescue No. 2	.....	Sept. 23, 1893	Feb. 1, 1894	Sept. 30, 1893	Dec. 27, 1893
Belle Helene	333.33	Feb. 7, 1893	June 30, 1894	July 24, 1893	Feb. 14, 1894
Houmas	.....	....do	....do	Sept. 25, 1893	Nov. 10, 1893
College Point	66.66	Nov. 8, 1893	Mar. 15, 1894	Oct. 18, 1893	Jan. 20, 1893
Hester	.....	Feb. 7, 1893	June 30, 1894	May 16, 1893	Feb. 18, 1894
St. Elmo	.....	....do	....do	Feb. 16, 1893	Apr. 13, 1893
Poche	.....	....do	....do	Mar. 17, 1893	Apr. 17, 1893
Terre Haute	100.	....do	....do	May 9, 1893	Dec. 28, 1893
Reserve	.....	Nov. 8, 1893	Feb. 1, 1894	Oct. 28, 1893	Feb. 23, 1894
Prospect	.....	Feb. 7, 1893	June 30, 1894	July 28, 1893	Oct. 22, 1893
Trudeau	216.66	Sept. 28, 1893	Feb. 15, 1894	Oct. 16, 1893	Mar. 26, 1894
Lafourche levee district:					
Home Place	.....	Nov. 7, 1893	Feb. 1, 1893	Nov. 2, 1892	Aug. 12, 1893
Melancon-Lemanville	272.53	Feb. 7, 1893	June 30, 1894	Nov. 13, 1893	Feb. 9, 1894
Brookstown	397.17	Sept. 25, 1893	Feb. 15, 1894	Nov. 6. 1893	Jan. 21, 1894
Jamestown Lower	126.65	Feb. 7, 1893	June 30, 1894	Nov. 13, 1893	Jan. 28, 1894
St. Emma	250.06	....do	....do	July 25, 1893	Sept. 16, 1893
Magnolia	243.28	....do	....do	Sept. 25, 1893	Dec. 31, 1893
White Rose	63.65	....do	....do	Apr. 14, 1893	Oct. 4, 1893
Providence	287.25	....do	....do	Nov. 30, 1893	Feb. 2, 1894
Waterford	489.87	Sept. 23, 1893	Feb. 15, 1894	Jan. 3, 1894	Feb. 14, 1894
Flagtown	22.44	Feb. 7, 1893	June 30, 1894	Apr. 8, 1893	Apr. 26, 1893
Speranza	342.79	....do	....do	Apr. 27, 1893	Aug. 31, 1893
Ashton	549.28	....do	....do	Nov. 6, 1893	Dec. 14, 1893
Coopersville	390.97	Sept. 25, 1893	Feb. 15, 1894	....do	Nov. 28, 1893

Name of levee.	Distance from center of levee to river bank.			Nature of river bank.	Remarks.
	Least.	Greatest.	Average.		
Pontchartrain levee district:	*Feet.*	*Feet.*	*Feet.*		
Shannon Lower	215	656	455	Washing, caving upper end	New levee
Conrad	125	485	405	Caving slowly	Do.
Ben Hur	200	510	380	Caving	Do.
Plaquemine Point	225	1,025	575	Practically permanent	Enlargement of old levee.
Maryland	115	290	260	Washing	New levee.
Hard Times	255	325	287	....do	Do.
Rescue No. 1	280	582	515	Caving slowly	Do.
Southwood Upper	314	450	405	....do	Do.
Rescue No. 2	305	1,200	975	....do	Do.
Belle Helene	280	645	615	Caving rapidly	Do.
Houmas	20	255	212	Washing slowly	Do.
College Point	115	212	155	Washing very slowly	Do.
Hester	355	695	525	Caving rapidly	Do.
St. Elmo	640	670	650	....do	Do.
Poche	150	260	205	Washing bank	Do.
Terre Haute	150	325	220	Washing slowly	Do.
Reserve	235	390	325	....do	Do.
Prospect	185	280	225	Caving	Do.
Trudeau	220	425	360	Caving slowly	Do.
Lafourche levee district:					
Home Place	590	800	700	Caving rapidly	Do.
Melancon-Lemanville	125	415	275	Caving periodically	Do.
Brookstown	275	490	420	Caving	Do.
Jamestown Lower	220	482	408	....do	Do.
St. Emma	283	554	475	Caving rapidly lower end.	Do.
Magnolia	110	320	280	Caving periodically	Do.
White Rose	268	380	350	Caving	Do.
Providence	90	310	275	Washing, caving upper end	Do.
Waterford	150	350	320	Washing, caving lower end	Do.
Flagtown	310	410	360	Washing bank	Do.
Speranza	155	230	195	Washing	Do.
Ashton	205	390	365	Caving slowly	Do.
Coopersville	125	435	360	Caving periodically	Do.

Fourth district levees, 1893–'94—Continued.

LAKE BORGNE AND BARATARIA LEVEE DISTRICTS.

Name of levee.	Below Cairo.	Bank.	Contractor.	Length of line.
Lake Borgne levee district:	*Miles.*			*Feet.*
Battle Ground	969.5	L.	Frank M. McLaughlin	5,[illegible]
Irving	975	L.	Philip J. Reilly	5,556
Caernarvon	978.5	L.	Isaac Henry	2,[illegible]
Orange Grove	979.5	L.	Jeffries & Dameron	2,[illegible]
English Turn	981	L.	....do	2,[illegible]
St. Clair	982	L.	....do	7,677
Mon Plaisir	983	L.	....do	2,775
Barataria levee district:				
Magnolia	979	R.	....do	3,[illegible]
Fort St. Leon Middle	980.5	R.	J. N. Ogden	3,[illegible]
Belle Chasse	981.5	R.	Henry C. Brown	5,[illegible]
Kearney	982.5	R.	Jeffries & Dameron	1,[illegible]
St. Anne	984	R.	W. L. Killebrew	1,[illegible]
Oakville	990	R.	....do	3,[illegible]
Dobard	992.5	R.	Jeffries & Dameron	
Star	995.5	R.	Isaac Henry	2,[illegible]
Ironton	999.7	R.	....do	2,[illegible]
Myrtle Grove	1,002.3	R.	Robert McNamara	[illegible]
Oakland	1,003.2	R.	Isaac Henry	1,[illegible]
Deer Range	1,004	R.	Jeffries & Dameron	2,[illegible]

Name of levee.	Length of axis of river covered.	Grade of levee above high water 1893.	Section.		
			Crown.	River slope.	Land slope.
Lake Borgne levee district:	*Feet.*	*Feet.*	*Feet.*		
Battle Ground	5,050	1.5–2.5	8	2 & 4 to 1	2½ to 1
Irving	4,800	2.5	8	3 1	2½ 1
Caernarvon	1,950	2.5	8	3 1	2½ and 4 1
Orange Grove	1,980	2.5	8	3 1	2½ 1
English Turn	3,400	2.5	8	3 1	2½ 1
St. Clair	8,700	2.5	8	3 1	2½ 1
Mon Plaisir	2,740	2.5	8	3 1	2½ 1
Barataria levee district:					
Magnolia	2,950	2.5	8	3 1	2½ 1
Fort St. Leon Middle	2,600	2.5	8	3 1	2½ 1
Belle Chasse	3,700	2.5	8	3 1	2½ 1
Kearney	1,880	2.5	8	2 & 4 1	2½ 1
St. Anne	2,000	2.5	8	2 & 4 1	2½ 1
Oakville	3,200	2.5	8	2 & 4 1	2½ 1
Dobard					
Star	3,200	2.5	8	2 & 4 1	2½ 1
Ironton	1,400	2.5	8	2 & 4 1	2½ 1
Myrtle Grove	800	2.5	8	3 1	2½ 1
Oakland	1,200	2.5	8	2 & 4 1	2½ 1
Deer Range	2,870	2.5	8	3 1	2½ 1

Name of levee.	Not fill.			Net embankment.		Filled excavations.	
	Least.	Greatest.	Average.	Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard
Lake Borgne levee district:	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*
Battle Ground	0	9.3	4.8	21,792.05	17½	2,940.53	17½
Irving	6.5	14.5	7.7	50,189.19	18½	2,814.01	18½
Caernarvon	10.4	12.8	11.8	40,278.19	19½	595.80	19½
Orange Grove	7.6	9.5	8.3	19,092.51	16	161.16	16
English Turn	5.6	9.6	7.7	22,551.90	14½	567.13	14½
St. Clair	1	6.8	3.4	26,199.82	14	309.69	14
Mon Plaisir	5.9	7.5	6.5	17,039	14	511.45	14
Barataria levee district:							
Magnolia	6.1	8.5	7.2	23,568.70	15	628.78	15
Fort St. Leon Middle	2	7.7	4.4	16,240.55	20	1,078.47	17
Belle Chasse	3	10.3	8.1	54,448.05	14.87	2,692.62	16
Kearney	7.7	9.5	8.5	18,468.72	14½	1,167.20	14½
St. Anne	.7	1.6	1.1	3,262.61	17.9	30.80	17.9
Oakville	5.1	7.6	6.4	20,119.36	17.9	847.17	17.9
Dobard					15		15
Star	.2	7.9	2.9	9,430.10	19½	590.03	19½
Ironton	.1	6.8	1.6	3,586.64	19½	668.36	19½
Myrtle Grove	5.3	8.8	7.1	7,523.59	16	280.59	16
Oakland	.8	5.7	2.8	1,858.87	19½	1,438.99	19½
Deer Range	5.7	7.4	6.8	20,741.45	15	870.44	15

Fourth district levees, 1893–'94—Continued.

LAKE BORGNE AND BARATARIA LEVEE DISTRICTS—Continued.

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Work commenced.	Work completed.
Lake Borgne levee district:	*Lin. ft.*				
Battle Ground	2,495	Apr. 1, 1893	June 30, 1894	Aug. 15, 1893	Jan. 22, 1894
Irving	1,379	....do	....do	Apr. 12, 1893	Oct. 21, 1893
Caernarvon	455	Feb. 6, 1893	....do	Oct. 18, 1893	
Orange Grove	None.	Apr. 1, 1893	....do	Oct. 19, 1893	Dec. 4, 1893
English Turn	887	....do	....do	Apr. 18, 1893	May 29, 1893
St. Clair	None.	....do	....do	Aug. 1, 1893	Nov. 4, 1893
Mon Plaisir	None.	....do	....do	Sept. 18, 1893	Oct. 31, 1893
Barataria levee district:					
Magnolia	50	....do	....do	Aug. 18, 1893	Feb. 15, 1894
Fort St. Leon Middle	50	Feb. 6, 1893	....do	Oct. 27, 1893	Dec. 18, 1893
Belle Chasse	1,427	Feb. 7, 1893	....do	July 25, 1893	Dec. 9, 1893
Kearney	None.	Apr. 1, 1893	....do	Nov. 6, 1893	Nov. 30, 1893
St. Anne	None.	....do	....do	Oct. 16, 1893	Jan. 18, 1894
Oakville	None.	Feb. 6, 1893	....do	Oct. 26, 1893	Mar. 7, 1894
Dobard		Apr. 1, 1893	....do		
Star	1,038	Apr. 6, 1893	....do	Oct. 2, 1893	Jan. 20, 1894
Ironton	200	Feb. 6, 1893	....do	Oct. 3, 1893	Jan. 19, 1894
Myrtle Grove	130	Nov. 8, 1893	....do	Oct. 30, 1893	Jan. 23, 1894
Oakland	220	Feb. 6, 1893	....do	Nov. 13, 1893	Jan. 22, 1894
Deer Range	None.	Apr. 1, 1893	....do	Dec. 4, 1893	Dec. 26, 1893

Name of levee.	Distance from center of levee to river bank.			Nature of river bank.	Remarks.
	Least.	Greatest.	Average.		
Lake Borgne levee district:	*Feet.*	*Feet.*	*Feet.*		
Battle Ground	20	125	74	Washing	New and enlargement; revetted.
Irving	300	740	450	Caving and sloughing.	New and enlargement.
Caernarvon	400	430	420	....do	New.
Orange Grove	190	240	215	Washing	Do.
English Turn	170	480	325	Caving and washing	Do.
St. Clair	130	650	355	Sloping	New and enlargement.
Mon Plaistir	130	260	190	Washing and sloughing.	New; revetted.
Barataria levee district:					
Magnolia	90	210	160	Washing and slight cave.	Do.
Fort St. Leon Middle	100	325	200	Washing	New and enlargement.
Belle Chasse	120	450	350	Caving and washing	Do.
Kearney	220	280	250	Washing and sloughing.	New; revetted.
St. Anne	200	230	215	Sloping	Enlargement.
Oakville	80	130	108	....do	New; revetted.
Dobard*					Levee at Deer Range built instead under Dobard contract, as more necessary.
Star	95	220	150	Sloping	Enlargement; revetted.
Ironton	25	100	60	Sloping and washing	Do.
Myrtle Grove	150	160	157	Washing	New.
Oakland	60	100	80	Sloping	New and enlargement; revetted.
Deer Range*	130	160	143	Washing	New.

*Supplemental articles of agreement dated November 25, 1893.

Fourth district levee revetment, 1893–'94.

Name of levee.	Below Cairo.	Bank.	Contractor.	Revetment.	
				Linear feet.	Price per linear foot.
Lake Borgne levee district:	*Miles.*				*Cents.*
Battle Ground	969.5	L.	James Byrne	5,482.2	56
Repose	976	L.	....do	700.6	56
St. Clair	982	L.	Robert McNamara, jr.	433.7	60
Barataria levee district:					
Magnolia	979	R.	J. M. May	414.6	25
Fort St. Leon Middle	980.5	R.	T. G. Bruning	812.6	63.49

Fourth district levee revetment, 1893–'94—Continued.

LAKE BORGNE AND BARATARIA LEVEE DISTRICTS—Continued.

Name of levee.	Below Cairo.	Bank.	Contractor.	Revetment. Linear feet.	Revetment. Price per linear foot.
Barataria levee district—Continued.	*Miles.*				*Cents.*
Kearney	982.5	R.	T. G. Bruning	1,212.8	2.0
Belle Chasse to Concession	983	R.	Andrews Bros. Construction Co.	193.7	"
Oakville	990	R.	T. G. Bruning	3 570.7	2.0
Happy Point	994	R.	Andrews Bros. Construction Co.	703.4	"
Star	995.5	R.	T. G. Bruning	3,217.3	2.0
Ironton	999.7	R.	do	2,032	2.0
Oakland	1,003.2	R.	do	1,220.4	2.0

Name of levee.	Contract time for completion.	Date of contract.	Work commenced.	Extension granted to—	Work completed.	Remarks.
Lake Borgne levee district:						
Battle Ground	Mar. 1, 1894	Jan. 2, 1894	Jan. 8, 1894		Feb. 26, 1894	New.
Repose	do	do	Feb. 20, 1894		Feb. 28, 1894	Do.
St. Clair	do	do	Jan. 8, 1894		Mar. 1, 1894	Do.
Barataria levee district:						
Magnolia	do	Feb. 16, 1894	Feb. 15, 1894		Mar. 8, 1894	Removing and rebuilding revetment.
Fort St. Leon Middle.	do	Jan. 2, 1894	Feb. 22, 1894	Mar. 5, 1894	Mar. 2, 1894	New.
Kearney	do	Jan. 23, 1894	Feb. 19, 1894	Mar. 10, 1894	Mar. 9, 1894	Do.
Belle Chasse to Concession.	do	Jan. 2, 1894	Jan. 29, 1894		Feb. 14, 1894	Do.
Oakville	do	do	Feb. 20, 1894	Mar. 10, 1894	Mar. 17, 1894	Do.
Happy Point	do	do	Feb. 13, 1894	do	Mar. 10, 1894	Do.
Star	do	do	Feb. 5, 1894	do	do	Do.
Ironton	do	do	Feb. 14, 1894	do	May 10, 1894	Do.
Oakland	do	do	Feb. 19, 1894		Mar. 1, 1894	Do.

SUMMARY.

Lower Tensas levee district:	
Total cubic yards of earthwork	786,357
Total linear feet of embankment	193,231
Total linear feet of axis of river covered	170,400
Total linear feet of revetment	11,562
Atchafalaya levee district:	
Total cubic yards of earthwork	980,463
Total linear feet of embankment	51,125
Total linear feet of axis of river covered	47,300
Lafourche levee district:	
Total cubic yards of earthwork	550,122
Total linear feet of embankment	37,370
Total linear feet of axis of river covered	35,360
Pontchartrain levee district:	
Total cubic yards of earthwork	903,404
Total linear feet of embankment	59,491
Total linear feet of axis of river covered	63,775
Barataria levee district:	
Total cubic yards of earthwork	189,542
Total linear feet of embankment	30,424
Total linear feet of axis of river covered	25,800
Total linear feet of revetment	13,382
Lake Borgne levee district:	
Total cubic yards of earthwork	205,042
Total linear feet of embankment	27,270
Total linear feet of axis of river covered	28,620
Total linear feet of revetment	10,516

GRAND SUMMARY.

Grand total cubic yards of earthwork	3,614,932
Grand total linear feet of embankment	398,920
Grand total linear feet of axis of river covered	371,544
Grand total linear feet of revetment	35,461

In accordance with the approved recommendation of the Commission, made by authority of the act of July 13, 1892, that contracts be entered into for levee work to be paid for from the appropriation for the fiscal year ending June 30, 1895, advertisements were issued and a number of contracts were entered into in anticipation of an appropriation to cover the allotments made for the coming fiscal year.

Contracts have been made for the following levees, the contracts providing that the works are to be completed by June 30, 1895. Many of these levees in the Pontchartrain levee district have been completed under a special arrangement between the contractors and the local board.

Name of levee.	Below Cairo.		Remarks.
	Distance.	Bank.	
ATCHAFALAYA LEVEE DISTRICT.			
	Miles.		
Lakeland	779.5	Right.	Work not begun.
St. Louis	856	Right.	Do.
Old Hickory	875	Right.	Do.
PONTCHARTRAIN LEVEE DISTRICT.			
Laurel Lower	839	Left.	Completed.
Ben Hur	846	Left.	Do.
Towles to Billings	815.5	Left.	Do.
Dennis	854.5	Left.	Do.
Grenada	858.5	Left.	Do.
Sunshine	860	Left.	Do.
Virginia	865	Left.	Do.
Lorlo	867	Left.	Do.
Point Clear	867.5	Left.	Do.
Point Clear Lower	869	Left.	Do.
Arizona	873	Left.	Do.
Revenue	874	Left.	Work begun.
Linwood	878	Left.	Completed.
Colomb Park	899	Left.	Do.
Uncle Sam	901	Left.	Do.
Convent	903	Left.	Work begun.
Venus	909	Left.	Work not begun.
Longue Vue	910.5	Left.	Completed.
Sport	915	Left.	Work not begun.
Hope Lower	917	Left.	Do.
Belle Point	924	Left.	Work begun.
Good Hope	934.5	Left.	Completed.
Rost	940	Left.	Work not begun.
Modoc	940.5	Left.	Do.
Frellsen	945	Left.	Do.
BARATARIA LEVEE DISTRICT.			
Live Oak extension	991.5	Right.	Work not begun.
LAKE BORGNE LEVEE DISTRICT.			
Sugar House	970.5	Left.	Work not begun.
Merritt	976	Left.	Do.
Stella	986	Left.	Do.
Greenwood	990	Left.	Do.

The following table shows the details of such of the above works as have been completed:

Fourth district levees, 1894 and 1895.

PONTCHARTRAIN LEVEE DISTRICT.

[Contract time for completion, June 30, 1895.]

Name of levee.	Below Cairo.		Contractor.	Length of line.	Length of axis of river covered	Grade of levee above high water, 1893.	Section.		
	Distance.	Bank.					Crown.	River slope.	Land slope.
				Feet.	*Feet.*	*Feet.*	*Feet.*		
Laurel Lower	839	L.	R. M. Quigley & Co	5,307	5,200	2.5	8	3 to 1	2½ to 1
Ben Hur Lower	846	L.	do	3,344	3,220	2.5	8	3 1	2½ 1
Dennis	854.5	L.	Eltringham Construction Co.	1,881	1,830	2.5	8	3 1	2½ 1
Towles to Billings	858.5	L.	R. M. Quigley & Co	3,344	3,200	2.5	8	3 1	2½ 1
Grenada	858.5	L.	Jeffries & Dameron	6,968	6,300	2.5	8	3 1	2½ 1
Sunshine	860	L.	T. W. Scott & Co	1,980	1,980	2.5	8	3 1	2½ and 4 to 1
Virginia	865	L.	Donovan, Daley & Co	2,417	2,280	2.5	8	3 1	2½ and 4 to 1
Lorio	867	L.	Quigley & Co	972	1,030	2.5	8	3 1	2½ to 1
Point Clear	867.5	L.	Donovan, Daley & Co	1,536	1,710	2.5	8	3 1	2½ 1
Point Clear Lower	869	L.	do	9,707	12,000	2.5	8	3 1	2½
Arizona	873	L.	Michael Hanick	2,388	2,150	2.5	8	3 1	2½ 1
Linwood	878	L.	R. M. Quigley & Co	4,152	4,040	2.5	8	3 1	2½ and 4 to 1
Colomb Park	899	L.	do	2,429	2,050	2.5	8	3 1	2½ to
Uncle Sam	901	L.	do	2,232	2,040	2.5	8	3 1	2½ and 4 to 1
Longue Vue	910.5	L.	do	2,817	2,950	2.5	8	3 1	2½ to
Good Hope	934.5	L.	Jeffries & Dameron	2,941	2,670	2.5	8	3 1	2½ 1

Name of levee.	Net fill.			Embankment.		Filled excavations.		Muck ditch.	Date of contract.
	Least.	Greatest.	Average.	Quantity.	Price per cubic yard.	Quantity.	Price per cubic yard.		
	Feet.	*Feet.*	*Feet.*	*Cu. yds.*	*Cents.*	*Cu. yds.*	*Cents.*	*Lin. ft.*	
Laurel Lower	0.8	10.2	9	41,197.38	11.47	250.94	11.47		Dec. 1, 1893.
Ben Hur Lower	1.4	10.3	9.6	39,220.96	11.47	335.82	11.47	100	Do.
Dennis	.9	8.7	8.1	17,105.98	9.23	99.80	5		Mar. 10, 1894.
Towles to Billings	.3	4.4	1.8	15,134.67	11.47	56.72	11.47		Dec. 1, 1893.
Grenada	1.2	11	2.4	55,998.51	10	7,109.18	10	6,745	Do.
Sunshine	1.4	12.3	12.8	33,018.70	12	307.21	12		Do.
Virginia	.8	12	10.6	36,702.37	11.40	260.81	11.40		Do.
Lorio	1.5	9.9	9.1	9,802.28	11.93	102.09	11.93		Do.
Point Clear	2.5	9.8	9.1	16,982.12	11.40	82.29	11.40		Do.
Point Clear Lower	1.4	8.6	2.9	60,711.09	9.90	125.36	9.90		Do.
Arizona	2.9	8.2	2.8	16,489.64	9.50	7.22	9.50		Do.
Linwood	2.4	13.2	10.5	64,102.52	12.30	712.15	12.39		Do.
Colomb Park	.6	11	8.9	26,319.56	10.69	744.49	10.69		Do.
Uncle Sam	1.8	12	11.1	36,911.98	11.39	279.03	11.29		Do.
Longue Vue	.4	9.9	9	31,581.14	11.39	469.23	11.39	95	Do.
Good Hope	.8	10.6	9.5	35,648.41	11	899.77	11		Do.

Name of levee.	Work commenced—	Work completed—	Distance from center of levee to river bank.			Nature of river bank.	Remarks.
			Least.	Greatest.	Average.		
			Feet.	*Feet.*	*Feet.*		
Laurel Lower	Jan. 15, 1894	Apr. 25, 1894	120	390	285	Washing; slow caving.	New.
Ben Hur Lower	Feb. 2, 1894	Apr. 23, 1894	230	400	365	Caving rapidly, upper end.	Do.
Dennis	Feb. 22, 1894	Mar. 21, 1894	62	303	250	Washing	Do.
Towles to Billings.	Jan. 15, 1894	Mar. 28, 1894	140	210	182	Practically permanent.	Enlargement.
Grenada	Feb. 3, 1894	Apr. 4, 1894	136	1,013	615	do	Do.
Sunshine	Jan. 11, 1894	Mar. 9, 1894	300	477	419	Caving periodically.	New.
Virginia	Jan. 5, 1894	Mar. 26, 1894	282	619	481	do	Do.
Lorio	Dec. 27, 1893	Feb. 12, 1894	143	238	185	Washing	Do.
Point Clear	Jan. 15, 1894	Mar. 14, 1894	106	304	250	Practically permanent.	Do.

Fourth district levees, 1894 and 1895—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

[Contract time for completion, June 30, 1895.]

Name of levee.	Work commenced—	Work completed—	Distance from center of levee to river bank.			Nature of river bank.	Remarks.
			Least.	Greatest.	Average.		
			Feet.	*Feet.*	*Feet.*		
Point Clear Lower.	Jan. 27, 1894	Apr. 30, 1894	55	850	470	Practically permanent.	Enlargement.
Arizona	Dec. 4, 1893	Mar. 8, 1894	215	585	455	....do	Do.
Linwood	....do	Feb. 14, 1894	565	722	680	Caving rapidly	New.
Colomb Park	Jan. 10, 1894	Mar. 14, 1894	154	465	255	Caving periodically.	Do.
Uncle Sam	Feb. 22, 1894	Apr. 17, 1894	90	335	272	Caving at upper end.	Do.
Longue Vue	Feb. 7, 1894	Apr. 27, 1894	273	485	325	Washing and slight caving.	Do.
Good Hope	Jan. 4, 1894	Feb. 5, 1894	115	230	185	....do	Do.

Summary for levees built under allotment for fiscal year ending June 30, 1895.

PONTCHARTRAIN LEVEE DISTRICT.

Total of earthwork placed to June 1, 1894, approximate	cubic yards..	548,769
Total of embankment completed	linear feet..	54,415
Total of axis of river covered	do.....	54,650

GRAND SUMMARY.

Grand total of earthwork placed to June 1, 1894, approximate	cubic yards..	548,769
Grand total of embankment completed	linear feet..	54,415
Grand total of axis of river covered	do.....	54,650

Grand summary of levee work done by the United States during year from June 1, 1893, to May 31, 1894.

Grand total of earthwork	cubic yards..	4,163,701
Grand total of embankment	miles..	85.84
Grand total of axis of river covered	do...	70.37
Grand total of revetment	linear feet..	35,461

In addition to the foregoing work of construction numerous minor repairs to the levees have been made in the way of restoring embankments injured by wave wash and the action of rains, repairing weak places, stopping leaks, clearing of weeds, etc.

Levee construction and repairs by the State and local levee district organizations have been very active during the year in all parts of the Fourth District, except in the Lower Tensas levee district (fifth Louisiana levee district), where comparatively little work, excepting that under direction of this office, has been done.

	Levee district.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Lake Borgne.	Barataria.
Aggregate number of cubic yards in levees on Mississippi River, May 1, 1893	9,805,050	9,292,000	4,324,904	6,479,200	1,452,400	1,682,400
Added by United States up to May 1, 1894	466,095	983,032	448,414	1,583,379	189,540	204,544
Added by others up to May 1, 1894	240,509	665,945	705,654	864,946	95,835	211,007
Sum	10,511,654	10,940,977	5,478,972	8,927,525	1,737,775	2,097,951
Lost by caving or abandonment, May 1, 1893, to May 1, 1894	62,700	69,161	279,811	67,073	106,783	155,590
Aggregate remaining May 1, 1894	10,448,954	10,871,816	5,199,161	8,860,452	1,630,992	1,942,361

Percentage of length of existing levee system built to date by the United States.

Lower Tensas levee district	52
Atchafalaya levee district	16.8
Lafourche levee district	14.4
Pontchartrain levee district	34.6
Barataria levee district	12.8
Lake Borgne levee district	10.2
Percentage of total length of existing levee system, Fourth District, Mississippi River, built by the United States	26.2

The report of Assistant Engineer H. S. Douglas, in local charge of the Lower Tensas levee district is as follows:

NATCHEZ, MISS., *May 31, 1894.*

SIR: I have the honor to submit the following report on the work under my local charge for the period from June 1, 1893, to May 31, 1894:

LOWER TENSAS LEVEE DISTRICT.

At date of last report the following levees under contract remained unfinished:

Grasmere to Wiccema (693 R), Fletcher to Minorca (699 R), Minorca to Minors (702 R).—The embankment had been completed, but owing to difficulties in obtaining tiles and delay caused by high water, the tile drains which the contracts required to be placed on these levees had not been put down. All other work undertaken had been finished and the levees generally were in better condition than at any time since the General Government undertook levee construction in 1882.

The first work undertaken after the high water of 1893 had fallen sufficiently was the putting down of tile drains on the unfinished levees under contract, as follows:

Grasmere to Wiccema (693 R).—The work of placing tile drains was commenced July 5, and was completed August 3, 1893. The total length of tiling placed was 25,740 feet.

Fletcher to Minorca (699 R).—On July 11 the work of laying tile drains was recommenced, and on July 21, 1893 the tiles were all in place. On this levee the total length of tile drains is 18,638 feet.

Minorca to Minors (702 R).—On July 10, the laying of tile drains was recommenced, and the work was completed July 31, 1893. The total length of tile drains placed is 17,258 feet.

With the placing of tile drains all work undertaken under the allotment for 1892–'93 was completed.

Under the allotment for the year of 1893–'94, covered by this report, the following levee work was undertaken under contract:

	Feet long.
Videl enlargement (615 R)	7,800
Davis Island enlargement (622 R)	11,894
Hard Times-Wilson enlargement (632 R)	14,900
Hardscrabble enlargement (643 R)	8,700
Bondurant enlargement (644 R)	5,305
Cottage Home, new levee (649 R)	2,461
Rifle Point, new and enlargement (690 R)	16,974
Lake Concordia, new and enlargement (695 R)	4,837
Morville to Greens, enlargement (715 R)	26,655
Forest Home new levee (723 R)	7,500
Glasscock, enlargement (726 R)	23,731
Lake Concordia revetment (695 R)	11,562

In addition to this, extensive repair work was done by day's labor at Hard Times (633 R), Evergreen (636 R), Hardscrabble (640 R), Bondurant (643.5 R), Kempe (657 R), Gibsons Landing (683.5 R), and Lake Concordia (695 R).

I give details of the work done, as follows:

CONSTRUCTION.

Videl (615 R).—Enlargement work: Length, 7,800 feet; height above natural surface, from 5.6 to 11.4 feet; grade, 3 feet above high water of 1892; crown, 8 feet; side slopes, 3 and 2½ to 1; contents, 27,038.65 cubic yards. This levee is situated on the west bank of Bayou Videl and connects the great dike across the bayou with the old levee on Lake Palmyra. It was of very weak section, having a crown of about 5 feet and side slopes of about 1½ to 1. During high water it had always been a source of anxiety, so it was decided to enlarge and strengthen it to a levee of standard section.

The contractors commenced work on November 27, 1893, but were greatly delayed by unfavorable weather and did not complete until February 28, 1894.

Davis Island (622 R).—Enlargement work: Length, 11,894 feet; height above natural surface, from 5.5 to 17.5 feet; grade, 2½ feet above high water of 1892; crown, 6 and 8 feet; side slopes, 3 and 2½ to 1 and 2½ and 1½ to 1; contents, 25,378.8 cubic yards. This levee is situated on Davis Island and is not connected with the main line of levees. There was a private levee encircling the island, which was weak in certain places. A specific allotment was made for the work, which was commenced by the contractors on September 25, 1893. The first 1,249 feet of the levee was enlarged to the standard section with crown of 8 feet and side slopes of 3 and 2½ to 1. The persons interested were dissatisfied with this, as it was making a part of the line unnecessarily strong as compared with the balance. After consideration the section

was changed and the remaining 10,645 feet was enlarged to a crown of 6 feet and with slopes of 2½ and 1½ to 1. The new earth was placed entirely on the land side for 6,145 feet and entirely on the river side for 4,500 feet. The work was prosecuted with great energy and was completed November 27, 1893.

Hard Times-Wilson (632 R).—Enlargement work: Length, 14,900 feet; grade 5 feet below existing levee; slope, 7 to 1; contents, 68,206.90 cubic yards. This levee was completed by the United States just before the high water of 1890. During that flood, and during the high water of 1891-'92 and 1893, it gave a great deal of trouble on account of innumerable leaks or sand boils. It is reasonably certain that the cause of these leaks is a stratum of almost pure sand underlaying the levee, and through which the water finds its way during high stages of the river. The plan of digging a deep ditch at the foot of the river slope, and filling it in with tamped earth had been tried, but with little success. Careful study was given the matter, and it was finally decided to endeavor to stop the leakage by enlarging the base of the levee, and covering up with clay, as far as possible, the loose sand stratum which had been exposed by excavating the barrow pits, from which the levee was built. This has been done by commencing the enlargement at a grade 5 feet below the crown of the levee on the river side, and carrying it on down across the berm and down into the old barrow pits on a slope of 7 to 1. This practically increased the width of the base of the levee an average of 60 feet, and as clay was used, wherever it could be obtained within a reasonable distance of the levee, it is expected that the leakage will be entirely prevented. The contractors commenced operations November 7, 1893, but failed to put on a large force and push the work rapidly to completion. As a result, when the river rose so as to interfere with the work, only about two-thirds of the amount contemplated had been done. As the portion worked on was complete in itself, it was decided to limit the contract to a length of 14,900 feet. Accordingly, final inspection was made and the work found completed April 3, 1894.

Hardscrabble (643 R).—Enlargement work: Length, 8,700; height above natural surface, from 6.2 to 12 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes 3 and 2½ to 1; contents, 25,290.01 cubic yards.

The portion of Hardscrabble worked on was all that now remains effective of the levee built by the United States in 1882–1885. It was of low grade and scant section. The work was carried on up to the lower end of Evergreen levee (636 R) adjoining, which was also very low in grade. The contractor commenced work October 2, 1893, and the levee was completed December 29, 1893.

Bondurant (644 R).—Enlargement work: Length, 5,305 feet; height above natural surface, from 6.7 to 18.8 feet; grade, 3 feet above high water of 1892; crown, 8 feet; side slopes, 3 and 2½ to 1; contents, 12,409.82 cubic yards. The portion of Bondurant worked on was the remaining effective portion of the levee built by the United States in 1882–1885.

Like all the levees built during that period, it was of lower grade and weaker section than modern levees. Contractors commenced operations October 3, 1893, and the levee was completed December 16, 1893.

Cottage Home (649 R).—New levee: Length, 2,461 feet; height above natural surface, from 7.8 to 12.8 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 and 2½ to 1 for 1,750 feet, and 3 to 1 river side and 2½ and 4 to 1 land side for 711 feet; contents, 34,179.25 cubic yards. This short piece of new levee was built to close a prospective gap in the old levee caused by the caving into the river of a salient angle. It was anticipated that a much longer and more costly line would have to be built, and several surveys were made. After careful study it was decided to be best to build the short line. Work was commenced by the contractor September 25, 1893, and the levee was completed November 17, 1893.

Rifle Point (690 R).—Enlargement and new levee: Length, 16,974 feet; height above natural surface, from 3.6 to 9.2 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes 3 and 2½ to 1; contents, 66,334.38 cubic yards.

This levee connects the United States Gibson Landing levee (683.5 R) with the United States Lake Concordia levee (695 R), and prior to being raised and enlarged was the weakest levee in the district. It was so full of holes and leaks it is a source of great surprise that it held the floods of recent years. The contractors commenced work September 21, 1893, and completed the levee February 17, 1894.

Lake Concordia (695 R).—New and enlargement: Length, 4,731 feet; height above natural surface, from 6.6 to 9.7 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 and 2½ to 1; contents, 38,336.77 cubic yards. The allotment of 1892-'93 was not sufficient to complete all the work undertaken on Lake Concordia levee under the names of Grasmere to Wiccema, Wiccema to Fletcher, Fletcher to Minorca, and Minorca to Minors levees. The work of the present season consisted of closing the different gaps left untouched under previous contracts. Work was commenced by the contractor October 2, 1893, and very slow progress was made, the levee not being completed until March 3, 1894.

Morville to Greens (715 R).—Enlargement work: Length, 26,655 feet; height above

natural surface, from 5 to 14.2 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes, 3 and 2½ to 1 for 21,605 feet, and 3 to 1 on the river side and 2½ and 4 to 1 on the land side for 5,050 feet; contents, 59,387.76 cubic yards. This levee was very low in grade, but with the exception of height, the section was generally much larger than the present standard. In places the old levee had a crown width of 20 feet and side slopes of 5 and 3 to 1, and, of course, where this was the case, the new work consisted merely in building a ridge of earth on top of the old levee. The original or first contractor failed to take any active steps toward doing the work, and after a lapse of several months the levee was relet. The second contractor moved on to the ground February 12, 1894, and the levee was completed April 27, 1894, the work having been considerably delayed by high water and excessive rains.

Forest Home (723 R).—New levee: Length, 7,500 feet; height above natural surface, from 6.5 to 13.8 feet; grade, 2½ feet above high water of 1892; crown, 8 feet; side slopes 2 and 2½ to 1 for 6,500 feet, and 3 to 1 on river side and 2½ and 4 to 1 on the land side for 1,000 feet; contents, 102,749.52 cubic yards. This was an extension upstream of the Fish Pond Levee built the previous season. The work was anticipated in previous report, as the continued caving of the river bank rendered it unadvisable to join the Fish Pond Levee on to the front line at the point originally intended.

The amount advertised was 100,000 cubic yards; but the survey developed the fact that 185,000 cubic yards would be required to complete the shortest safe line. Work under the contract was restricted to about the amount advertised, and with this amount 7,500 feet of the levee was completed. The front line of levee still holds, although it was found necessary to build a short piece of temporary levee to prevent a gap at a salient angle. This short piece of levee was 434 feet long, and contained 1,953.6 cubic yards. Work on the main line was commenced by the contractors January 8, 1894, and the work was completed May 9, 1894, after being greatly delayed by unfavorable weather.

Glasscock (726 R).—Enlargement work: Length, 23,731 feet; height above natural surface, from 6 to 13.6 feet; grade, 2½ feet above high water of 1892; crown, 4 feet; side slopes, 1½ to 1, both sides; contents, 13,438.53 cubic yards.

This levee was originally built by the United States in 1882, 1883, 1884, and was very low in grades. As it is located near the lower end of the levee system, it has, during high stages of the river, water on both sides, the difference between the back and front water seldom exceeding 6 feet. This will be the case until the levee system is extended. For this reason it was not considered necessary to increase the base of the existing levee. The work done was the least expensive possible, and consisted merely of a light ridge of earth with a crown only 4 feet wide built up on top of the old levee to prevent the water running over the crown and possibly washing out a crevasse in time. Contractor commenced work November 6, 1893, and completed the levee March 2, 1894.

Lake Concordia Revetment (695 R).—Owing to the continued caving of the river banks having reunited the river and the lake, a certain stretch of Lake Concordia levee is badly exposed to wave wash. To prevent injury to the levee and possible disaster during storms at high water, it was decided to revet the embankment where exposed. Accordingly, under contract, 11,562 running feet of levee was revetted in a substantial manner with cypress lumber. The style of revetment was similar to that used elsewhere in the district. Work was commenced by the contractors January 11, 1894, and the revetment was completed March 15, 1894.

This completes all work that was done under contract during the season.

REPAIRS.

Extensive repairs to the line of levees were made by hired labor force. The character of this work is such that it can not well be done by contract. A quarter boat, in charge of an overseer, and with a force of laborers with tools, etc., arrived at Hard Times August 11, 1893, and commenced repair work on Hard Times levee (633 R) and Evergreen levee (636 R).

About 3,000 cubic yards of earth were added to the levees to reinforce weak places, and 7,600 feet of levee was cleared of small trees, briers, and weeds. The force was then transferred to Hardscrabble (640 R) and Bondurant (643.5 R) levees. During the month of September these levees were cleared of weeds, briers, etc., for a length of 18,000 feet, 3,500 feet of levee were resodded, and 6,500 cubic yards of earth added to the embankment to repair weak and low places. During October the force was moved first to Kempe (658 R), and then to Gibsons Landing (683.5 R). At Kempe the levee was cleared for 18,000 feet, resodded for 2,500 feet, and 4,400 cubic yards of earth were placed in weak and low places. At Gibsons Landing 5,200 feet of levee were cleared, 500 feet resodded, and 900 cubic yards of earth placed in the levee to repair rain and wave wash. Before all the repairs necessary to Gibsons Landing

Levees were completed the force was transferred to the lower district, where the work was more urgent.

The whole line of the new Lake Concordia levee had been badly rain and wave washed during the high water of 1893, and portions of the levee were grown up with weeds. A competent man was placed in charge with instructions to hire local labor with tools and repair all damage to the levee.

Work was commenced September 15, 1893, and prosecuted with great energy to completion October 18, 1893. During this time 62,600 running feet of levee were repaired, about 6,000 cubic yards of earth were placed in the levee to repair rain and wave wash, and 3,250 feet of embankment were resodded.

SURVEYS.

During the period covered by this report surveys have been made as follows:

Reid levee (605 R).—Two miles of new levee line were surveyed, located, and staked out, 4 miles of line were restaked, and 5 miles of bank line traversed.

Christmas and Diamond Bend levees (608 to 614 R).—Traversed for a length of 50,800 feet and cross-sectioned for raising and enlargement for a length of 42,000 feet.

Vidal levee (615 R).—Surveyed and cross-sectioned for raising and enlargement for 8,700 feet.

Davis Island levee (622 R).—Restaked for a length of 20,000 feet.

Hard Times-Wilson levee (632 R).—Traversed and cross-sectioned for the enlargement for 18,700 feet.

Hardscrabble levee (643 R), 8,700 feet long; Bondurant (644 R), 5,361 feet long; Rifle Point (690 R), 16,974 feet long; Lake Concordia (695 R), 4,737 feet long; and Morville to Greens (715 R), 28,469 feet long, were restaked.

Forest Home levee (723 R).—Surveys were made for an extension of Fishpond levee upstream under this name, and 19,112 feet of main levee line were staked out. In addition to this 4,275 feet of temporary levee line were surveyed, to cover possible gaps in old levee before new one was finished. About 4 miles of bank line were traversed.

Glasscock levee (726 R).—Cross-sectioned for raising for a length of 32,931 feet, and 6 miles of bank line were traversed.

Bougere Bend (739 R).—Extension surveys were made in this locality. Two lines for a levee to close the Bougere crevasse were located. Four radial or cross-country lines, each about 1 mile long, were ran back from the river bank and leveled to determine topography, and these lines were prolonged across the river by means of soundings. The bank line on either side of the river was traversed to determine changes, and pits were sunk along the levee lines to ascertain nature of underlaying strata. In all, 15 miles of levee line were located, 4 miles of radial lines chained and leveled, four cross-sections of the river were sounded, six miles of levels were run to ascertain height of immediate river bank, and 20 miles of shore or bank line were traversed.

Sketch maps and profiles of the several levees were prepared by the survey party in the field.

LOSS OF LEVEES BY CAVING OR ABANDONMENT.

During the year 7,500 running feet of levee, containing 57,700 cubic yards of earth, have been lost in the Lower Tensas District by caving or abandonment. Of this amount 2,800 feet of levee, containing 39,500 cubic yards, were lost by caving.

The balance was abandoned because the line could be shortened and a better location found.

The loss of levees from these causes from 1882 to 1893 was 56.75 miles, or at the rate of 5.16 miles per year. On the basis of the present length of the system—125 miles—this was a loss of a little over 4 per cent per annum. During the past season the loss has been only a little over 1 per cent.

SUMMARY.

The work done during the season is as follows:

	Miles.
Length of tile drains put down	11.5
Length of old levee enlarged	22
Length of new levee built	2.8
Total length of levees built and enlarged	24.8
Length of levee revetted	2.2
Length of levee repaired	21.1
New levees surveyed	21.4
Old levees cross-sectioned	19.4
Bank or shore lines traversed, etc	46.7

There has been no change of importance in the methods of supervision or employés engaged in this duty, and the work has been carried on without incident worthy of mention.

There has been practically no change in the length of effective levee in the Lower Tensas district.

The length of levee built entirely or extensively enlarged by the United States has been increased 11.1 miles during the year, making a total length of 66.8 miles, or over 52 per cent of the total length.

The condition of the levees at close of this report is generally fair. A marked feature of the year's work has been the small amount of levee lost by caving banks, which has permitted the expenditure of the bulk of the allotment in strengthening, raising, and enlarging existing levee lines of weak section.

At present 26.6 miles of levees are less than 2½ feet above high water of 1882, at the following points:

	Miles.
(610 R) Christmas and Diamond Bend levees	4
(620 R) Palmyra levee	5
(624 R) Ashwood levee	1
(625 R) Buck Ridge levee	2.1
(648 R) Marshall levee	2.1
(657 R) Kempe levee	3
(700 R) Palo Alto and Vidalia levee	1
(705 R) Arnauldia to Moro levee	5.7
(721 R) Greens levee	1
(724 R) Ashley levee	1.7

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer William J. Hardee, in local charge of the Atchafalaya, Lafourche, and Pontchartrain levee districts, is as follows:

BATON ROUGE, LA., *May 31, 1894.*

SIR: I have the honor to submit the following report for works under my local direction for the year ending May 31, 1894:

GENERAL METHODS.

Surveys.—As the majority of prospective levees to be constructed had been surveyed and staked previous to the ending of my last annual report, and there existed plenty of time in which to make the additional ones considered necessary after the subsidence of the 1893 high water, it was deemed more expedient not to organize a regular survey corps to be quartered on one of the boats, but to send a surveyor, accompanied by a rodman and one skilled laborer, into the field to make such surveys as were required, and this was done.

The grade for all levees was established at an elevation equal to 2½ feet above the 1893 high water, with cross sections corresponding with broken slopes, as was done and reported last year.

Tile drainage.—No tile drains were laid during the year covered by this report.

During April the river reached a stage which put the water several feet deep against the embankment. It shortly receded and owing to its elevation it could not be determined if the tile drains placed last year would operate successfully.

An inspection of them was made and some were found to be running freely, considering the small amount of water against the embankment. Where not found discharging it could not be decided whether failure was due to imperfections in the drains or low stage of water, though the latter appears most reasonable.

Muck or base ditches.—The same general plan of cutting these ditches, only at localities where it was presumed hidden substances might exist, to later impair the integrity of the levee, was continued.

Repairs.—During August and September inspectors were sent into the field and employed labor, constituting repair forces.

During the flood of 1893 nearly all of the new levees had suffered more or less from wave wash. Further, the sod on the river side which had not become well rooted before the river rose and covered it had died out.

During the first spring and summer after the completion of a levee there is usually a strong growth of weeds upon it, which if not cut and removed before maturity,

will grow as prolifically the following season, and in a measure perpetuate themselves. The growth of weeds is objectionable in that it chokes the grass, prevents its growth and consequent spreading, and in addition shades the embankment and keeps it soft.

Supervision.—The method of supervision was, in general, the same as last year. Two surveyors at $125 per month each, and one at $100 per month, were employed, whose duty consisted in making surveys for new levees and the execution of all instrumental work at levees constructing and when completed.

A large number of inspectors were employed and paid $60, $75, or $90 per month, according to the size or number of levees under their local charge.

The duties of inspectors consisted in seeing that specifications and detailed instructions were fulfilled, keeping a daily journal or record of the work, and submitting weekly reports of force at work and progress.

Inspection.—From time to time, as the boats were assigned to duty under my direction, the steamer *Ruby*, tugs *Comstock* and *Tilda*, and the launch *Alaska*, were used for short periods in making inspection of levees.

ATCHAFALAYA SECTION.

Allotment.—An allotment of $152,000 was made for levee work in this district for the fiscal year ending June 30, 1894. In addition, an unexpended balance of $25,344.19 was brought forward from the 1893 allotment, increasing the amount available for 1894 expenditure to $177,344.19. An allotment of $152,000 for fiscal year ending June 30, 1895, was also made.

Construction.—Contracts had been made during fiscal year of 1893 for construction of new levees at following places, to be paid for from 1894 allotment:

Belle Valo (825.5 R), Missouri (840 R), Rebecca (857 R), Dunboyne Upper (865 R), Bello Grove (870 R), Celeste (872 R), Mount Salem (872 R), and Babin (879 R).

Of these Belle Vale, Missouri, Celeste, and Mount Salem were commenced previous to May 31, 1893.

The high water of 1893 caused a suspension of operations at each for a short time. Following the subsidence of the flood work was promptly resumed. The other levees were commenced early in the fall and completed during the winter.

As a considerable balance of funds remained, contracts were made for the construction of new levees, to be paid from same allotment, at Torras (766 R), Fleta (786 R), Provosty (798 R), St. Francis Church (798.5 R), Poplar Grove (831 R), Anchorage (832 R), Homestead (832.5 R), Port Allen (833 R), Nereaux (851 R), St. Louis (856 R), Golden Ridge (861 R), and Harrell (866 R).

When the bids had been opened and proposed prices ascertained, Poplar Grove, Anchorage, and St. Louis were omitted for want of funds.

As soon as notice of acceptance of bids were received work was promptly started on these levees, and all were completed by March 15, 1894.

Caving bank rendered a new levee necessary at Dorcyville (868.5 R), and as there were sufficient funds on hand to do the work proposals were invited by circular letter and it was put under contract to John Scott & Sons.

Between Provosty (798 R) and St. Francis Church (798.5 R) levees the existing levee, 1,354 feet long, was of low grade and small section. As it was considered to have permanent location, it was considered advisable to raise and enlarge it to standard grade and section, and as funds were available it was done under supplemental agreement with Hartnett & O'Brien, contractors for Provosty levee.

At St. Francis Church (798.5) levee, a road crossing was constructed to afford the public access to a public ferry without doing injury to the embankment.

Full information as to lengths, heights, sections, cubic contents of embankments, etc., for individual levees will be found in tabulated statement.

Muck or base ditch.—Of the 51,230 feet of levee built in this district, 758 feet of muck ditch, measuring 4 feet at top, 2 feet at bottom and 3 feet deep, was dug, being about 1 per cent of the total length of levee.

At Provosty (798 R) levee the upper end of levee crossed the bed of an old crevasse. Owing to the uncertain character of the ground which was to form the base of this part of the levee, and the opinion that "rack heaps" of timber might be covered by the deposit, it was considered advisable to fully explore same and expose such substance for removal. To accomplish this a base ditch was dug near the center of the levee and parallel thereto, measuring 10 feet wide on top, 5 feet wide on the bottom, and 6 feet deep.

This ditch was 750 feet long. No timber "racks" were found, but only here and there a large log, which was dug out and removed.

At Fleta (786 R) the levee line traversed a section of ground on which there was an old sawmill. A considerable depression had originally existed, which was filled with sawdust. A ditch was dug measuring 7 feet wide at top, 3 feet wide at bottom, 5 feet deep, and 523 feet long, to explore this sawdust bed, and in addition a

layer of several feet of sawdust was gathered and removed from the ground covered by the base of the embankment.

Surveys.—From time to time surveys were made for construction of new levees at the following points:

Lakeland (799.5 R), Lobdell (823 R), Allendale (825 R), Poplar Grove upper (831 R), Poplar Grove lower (831.5 R), Anchorage (832 R), Australia (846.5 R), Tullier (850 R), St. Louis (856 R), Whitecastle (869 R), and Old Hickory (873 R).

Of these, Lakeland, Poplar Grove upper, Poplar Grove lower, Anchorage, St. Louis, and Old Hickory have been put under contract to be paid for from the 1895 allotment. Up to May 31, 1894, no work has been done on any of them.

General effectiveness.—Based on the linear length of the river, the channel taken as the line of effective measurement, the 51,230 feet of embankment built in this district represents 47,589 feet of actual protection.

The comparative lengths for individual levees will be found in the tabulated statement for levees.

The general line of levee in this district, based on present standard of grade, is estimated to average 13 feet high. Taking the contents of embankment of these measurements as a basis of comparison, the 51,230 feet of embankment constructed would represent, approximately, 42,890 feet of levee, if applied at points where the average prevails.

Repairs.—Wave wash was restored, weeds removed and sodding replaced by hired labor at Barroza upper (823 R), Barroza middle (823 R), Belair (828 R), Eliza (842 R), Medora (852 R), Mayflower-Union (853 R), Fortville (855 R), Fortville lower (855 R), and Evergreen (857 R).

In addition to the above work, wherever the drainage of borrow pits had become impaired by sand deposit or otherwise, the drainage was restored by the same force.

Abandonment and condition.—During the year a part of the Red River Landing to Atchafalaya River (766 R) and Evergreen (857 R) levees was abandoned by the construction of new levees. The total length abandoned was 1,546 feet, embracing 19,161.13 cubic yards.

At the close of the year ending May 31, 1894, there are 173,146 feet of existing good levee built, in whole or in part, by the United States in this distict.

Protection.—Up to the date of closing this report the river has lacked an average of 9 feet of highest water stage and no protection work has been necessary.

At Fleta (786 R) levee, owing to the inferior road in rear of levee during bad weather, the embankment was being greatly injured by passing vehicles. To prevent further damage, a strong and permanent wire fence was erected at the land foot of the embankment, next to the road. Several "spurs" or cross fences were run across the top of the levee to obstruct passage of vehicles over that portion of it. The fence accomplished its mission in a most satisfactory manner.

LAFOURCHE SECTION.

Allotment.—An allotment of $90,000 was made for levee work in this district for the fiscal year ending June 30, 1894, and a similar amount for the fiscal year ending June 30, 1895.

An unexpended balance of $2,698.12 was brought forward from the 1893 allotment, increasing available funds for 1894 to $92,698.12.

Construction.—At the close of my last annual report contracts were in existence for the construction of the following levees, to be paid from the 1894 allotment.

Melancon-Lemanville (893 R), Jamestown lower (897.5 R), St. Emma (904 R), Magnolia (911 R), White Rose (918 R), Flagtown (936.5 R), Speranza (937 R), and Ashton (940 R).

Of these Flagtown was completed and work had been started on White Rose and Speranza, but was suspended for a few weeks, during the flood of 1893.

As soon as the water had fallen several feet work was resumed and the levees completed in a short while.

At later dates during the fall the remaining levees were commenced and all completed by February 1, 1894.

To expend the available balance, surveys were made and bids invited for construction in Brookstown (896.5 R), Waterford (931 R), Providence (932 R), Coopersville (944 R), and Alice (945 R).

The Alice levee bids were rejected owing to lack of funds. As soon as notices of acceptance of bids were received, large forces were put to work at each levee, and all were completed well in advance of specified time.

The existing levee, 565 feet long, between the two sections of new levee at Melancon-Lemanville (893 R), is well removed from the river and having low grade and small section it was deemed advisable to bring it to same grade and section as new levee on each side of it, which was done through supplemental agreement with Ovide Lacour, contractor for Melancon-Lemanville levees.

Details for individual levees will be found in tabulated statement.

Muck or base ditches.—No muck or base ditch was dug at any of the levees in this district, as the surrounding conditions did not warrant doing so.

General effectiveness.—The 31,944 feet of levee built represents 30,220 feet of actual protection, the channel of the river taken as the line of effective measurement. The comparative lengths for individual levees will be found in tabulated statement.

The general line of levee in this district is estimated to average 11 feet high. If applied at localities where the average exists, the 31,944 feet of embankment built would equal 28,085 feet.

Repairs.—At Buena Vista Minnie (896 R), Jamestown (897 R), St. James Church (901 R), St. James Estate (902.5 R), Home Place (905.5 R), Lone Star (941.5 R), and Davis (943 R) levees wave wash was restored, weeds cut and removed, embankment resodded, and impaired drainage of pits restored by hired labor.

Abandonment and condition.—During the year a portion of the Jamestown (897 R) and Home Place (905.5 R) levees was abandoned on account of the construction of new levees. The total length abandoned was 496 feet, embracing 7,420.35 cubic yards.

At the close of the year ending May 31, 1894, there are 58,764 feet of good existing levee built entirely by the United States in this district.

Protection.—Up to the close of this report the river had merely left its banks and was several feet deep against some of the embankments.

It has since receded and at present is against none. No protection work has been necessary.

PONTCHARTRAIN SECTION.

Allotment and disposition.—An allotment of $150,000 was made for levee work for fiscal year ending June 30, 1894, and a similar amount for fiscal year ending June 30, 1895.

A balance of $7,551.72 was brought forward from 1893 allotment, making $157,551.72 available for expenditure during 1894.

Construction.—At the close of my last annual report contracts were in existence for the construction of levees at the following places, to be paid from 1894 allotment:

Shannon lower (837 L), Maryland (872 L), Rescue (874 L), Southwood upper (874.7 L), Belle Helene (879 L), Houmas (890.5 L), Hester (908.5 L), St. Elmo (910 L), Poche (911 L), Terre Haute (921 L), and Prospect 936 L).

At the close of that report, the St. Elmo and Poche levees were completed and work had been commenced at Maryland, Rescue, Hester, and Terre Haute.

At Hester the contractors experimented with a mechanical device with which to construct the levee, but meeting with many breakdowns and lack of success finally abandoned the machine.

Work at this levee was resumed October 12, 1893, with a team force. A levee called "Venus" was staked to join the lower end of the main line with the United States Tessier levee just below. It was thought the Venus levee would be constructed in advance of high-water period, and the contractors for Hester levee were accordingly notified that they would not have to build the lower wing.

Shortly following the completion of the main line, and before work was commenced at Venus, the river rose rapidly and threatened to pour through the opening. A force of men and teams were secured by the day, under open-market agreement, and under the direction of an inspector, built the wing. There was more than 3 feet of water against the wing embankment when completed.

At Maryland, Rescue, and Terre Haute levees operations were interrupted for a short while by the high water of 1893.

Work was promptly resumed at Terre Haute following a recession of the flood and the levee completed on December 28, 1893.

At Rescue the embankment was about 20 per cent completed when the crevasse which occurred at that place on June 23, 1893, washed it entirely away.

The line was later on reestablished at a considerable distance in the rear of the original location, to avoid the washouts made by the crevasse. This revised line was much longer and embraced about twice the yardage of the original contract. The contractor for the original line was given an equivalent yardage at the lower end, and the remainder of the line let under a new contract at a subsequent date.

During the fall additional contracts were made for levees at Conrad (840 L), Ben Hur (846 L), Plaquemines Point (845 L), Hard Times (873 L), Rescue (874 L), College Point (903 L), Reserve (923 L), and Trudeau (949 L).

The contract for Rescue is represented as "Rescue No. 2" throughout this report.

The contract for Trudeau covered that portion of the levee which had not been completed under the annulled P. J. Coffman contract of November 5, 1892.

About one-fifth of the work contemplated under the College Point contract had to be omitted for want of funds.

The majority of the 1894 contracts were vigorously prosecuted by large forces, resulting in their completion early in the season.

Of the entire number only two—Reserve and Trudeau—required extension of dates for completion, the former two days and the latter thirty days.

Surveys.—Numerous surveys were made from time to time for construction and enlargement of levees. When the flood of 1893 had receded, and the water had reached a low stage so that the condition of bank, etc., might be carefully noted and considered, a detailed inspection was made, covering the entire levee line in this district. As a result of that inspection surveys were made at the following places:

Laurel Lower (839 L), Ben Hur Lower (846.5 L), Towles to Billings (851.5 L), Dennis (854.5 L), Grenada (858.5 L), Sunshine (860 L), Virginia (865 L), Lorio (867 L), Point Clear (867.5 L), Point Clear Lower (869 L), Arizona (873 L), Revenue (874 L), Linwood (878 L), Colomb Park (899 L), Uncle Sam (901 L), Convent (903 L), Venus (909 L), Longue Vue (910.5 L), Sport (915 L), Hope Lower (917 L), Belle Point (942 L), Good Hope (934.5 L), Rost (940 L), Modoc (940.5 L), and Frellsen (945 L).

At different dates these levees were put under contract to be paid for from the 1895 allotment.

The Pontchartrain levee board arranged with the holders to complete all but Venus, Sport, Hope Lower, Rost, and Modoc levees in advance of 1894 high water.

Large forces were employed and the contractors particularly diligent in pushing work. All were completed well in advance of the flood, and by April 27, 1894, except Revenue, Convent, and Belle Point.

These are large works. They were put under contract so late in the season that only a portion of the work could be done when operations were suspended during March and April by the river reaching a stage where it left its banks and covered the ground from which construction material must be obtained.

At Grenada (858.5 L) the work done consisted in rectifying and enlarging an old levee which was very badly cut with leaks.

The alignment, originally bad, was corrected, the old embankment cut down, and wasted within the base stakes of the new cross section, and a large base ditch, measuring 10 feet at top, 4 feet at bottom, and from 5 to 6 feet deep, dug. This ditch was 6,745 feet long.

In connection with the 1894 and 1895 contracts it is to be stated that wherever it was deemed "a wing," by which is meant that portion of the levee connecting the main or back line with the old levee in front, would afford only temporary service and would within several years have to be abandoned by the continuation of the main or back line, such wing was, as a matter of economy, built to a lower grade and smaller section than the practically permanent portion of the levee.

This was done at Conrad (840 L), Rescue No. 1 (874 L), Uncle Sam (901 L), College Point (902 L), Hester (908.5 L), and Poche (910.5 L).

To afford access to a public ferry and to prevent misuse of the levee a road crossing was built at Plaquemines Point (845 L.), and Point Clear Lower (869 L).

Details of all work will be found in accompanying tabulated statement.

Muck or base ditch.—On the 116,808 feet of levee built, 2,685 feet of muck or base ditch, measuring 4 feet at top, 2 feet at bottom, and 3 feet deep was excavated, being about 2¼ per cent of the total length of line.

General effectiveness.—The 116,808 feet of levee built represents 118,878 feet of effectiveness, the channel of the river being taken as the line of measurement. The comparative lengths for individual levees will be found in tabulated statement.

The levee system in this district is estimated to average about 11 feet high. The 116,808 feet of completed levee would therefore represent 87,612 feet if placement had been made at points where the average prevails.

Repairs.—Wave wash was restored, weeds cut and removed, embankment resodded where required and drainage of borrow pits corrected by hired labor at following levees:

Shannon (837 L), Martinez (842 L), Lopez (844.5 L), Gay to Hollywood (845 L), Burtville (847 L), Woodstock (847.5 L), Hermitage (850 L), Towles (851 L), Billings (852.3 L), Grenada to Mount Olive (856.5 L), Jolisant (858.8 L), Oakley to St. Gabriel (862 L), Southwood (875.5 L), Southwood Extension (876.5 L), Ashland to Linwood (878 L), Dicharry (882 L), Dicharry Lower (883 L), Burnside (891 L), Union Upper (893 L), Union (893 L), Union Lower (893 L), Tippecanoe (894 L), Irvine (894.2 L), Petavin (894.5 L), Whitehall (895 L), Lilly (900.5 L), College Point to St. Michael (903.5 L), Tessier (909.5 L), St. Elmo (910 L), Poche (911 L), Hope (916.5 L), Terre Haute to Hope (919.5 L), Cornland (922 L), Destrahan (939 L), Frellsen to Almedia (942.5 L), and Southport (955.5 L).

In addition to the work specified, wherever wooden revetment had been placed during last high water, it was carefully removed and stored for future use.

Under open-market agreement men, mules, and tools were furnished by Messrs. Porter & Stamps, and the "Coffman" portion of the Trudeau (949 L) levee was thoroughly repaired and put in good condition.

Abandonment and condition.—During the year portions of the Shannon (837 L),

Conrad (840 L), Gay to Hollywood (845 L), Southwood (875.5 L), Ashland to Linwood (878 L), Lilly (900.5 L), College Point to St. Michael (903.5 L), St. Elmo (910 L), and Poche (911 L) levees was abandoned on account of construction of new lines. The total length of levee abandoned was 5,309 feet, embracing 67,073.65 cubic yards.

At the close of the year ending May 31, 1894, there are 245,505 feet of good existing levee built wholly or in part by the United States in this district.

Protection.—As the river merely left its banks and acquired a depth of several feet against the embankment, afterwards receding, no protection work has been necessary except at Prospect (936 L), where, during a storm, the embankment was badly wave washed.

To prevent further washing an inspector and material was sent to the levee, and a rough, temporary wooden revetment constructed.

SIMMESPORT LEVEE.

(Under the appropriation for improving Red and Atchafalaya rivers.)

This levee was originally 1,358 feet long, of which 438 feet were rectified and rebuilt last season.

An additional allotment of $1,000 was made this year with which to repair and rebuild the remaining length.

The work was let by formal advertisement to F. L. Cason. Operations were instituted on November 12, 1893, but a small force was employed, and the contract completed and accepted on December 9, 1893.

The 920 feet were enlarged to a grade 2½ feet above the 1892 high water; crown, 6 feet wide; river slope, 3 to 1, and land slope 2½ to 1, which is the same grade and section on which the 438 feet was built last season.

The work embraced 5,326.37 cubic yards, at 14.99 cents, which, with cost of inspection and traveling expenses of surveyors and inspector, aggregate a cost of $886.54.

Very respectfully, your obedient servant,

W. J. HARDEE,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer John Smyth, jr., in local charge of the Lake Borgne and Barataria levee districts, is as follows:

NEW ORLEANS, LA., *May 1, 1894.*

SIR: I have the honor to submit the following report of the surveys, construction, and repair of levees in the Lake Borgne and Barataria levee districts for the year ending April 30, 1894.

I was assigned to duty as assistant engineer in local charge of these districts on July 1, 1893.

At date of last annual report the only work under construction was Irving levee (975 L), in the Lake Borgne district, where about 20,000 cubic yards of earth had been put in place. For further mention of this levee see "Construction," Lake Borgne district.

SURVEYS.

Surveys were made or revised for the following proposed levees, new and enlargement:

Battle Ground (969.5 L), Irving (975 L), Carnarvon (978.5 L), Orange Grove (979.5 L), St. Clair (982 L), Mon Plaisir (983 L), Magnolia (979 R), Fort St. Leon middle (980.5 R), Belle Chasse (981.5 R), Kearney (982.5 R), St. Anne (984 R), Oakville (990 R), Dobard (992.5 R), Star (995.5 R), Ironton (999.7 R), Myrtle Grove (1,002. 3 R), Oakland (1,003.2 R), Deer Range (1,004 R).

Preliminary surveys have been made for the following levees to be built with funds for the fiscal year ending June 30, 1895: Sugarhouse (970.6 L), Merritt (976 L), Poydras (977.4 L), Carnarvon upper (978 L), Stella (986 L), Greenwood (990 L), Kearney upper (982.2 R), Kearney lower (983.1 R), Live Oak upper (991.8 R), La Rose (1,003.4 R), Purcell (1,003.8 R).

Levees will probably be necessary at Concord lower (986.7 R), Cedar Grove (989 R), Sarah (990.7 R), and Fairview (996.7 L), before the high-water season of 1895.

LAKE BORGNE DISTRICT.

Construction.—Battle Ground levee (969.5 L). This consists of five sections, namely: Slaughter House extension, Gueringer, Rhodes, Chalmette Cemetery, and Mercier.

Slaughter House extension section was enlarged by United States force on quarter-

boat *Delta* to withstand the high water of 1893. But from station 5 to station 21+83 it was too low, and in consequence has been raised this year to a net grade of 1.5 feet above the highest water of 1893. The portion of levee enlarged this year is 1,683 feet long and joins at its lower end the upper end of Roy levee of 1892-'93.

Gueringer section connects the Roy and Bonzano levees of 1892-'93. It is practically a new levee, and the portion of old levee abandoned was used in construction of the new levee.

Rhodes section connects Bonzano and Chalmette cemetery levees of 1892-'93, and consists of 317 feet of enlargement and 1,034 feet of new levee. The Chalmette cemetery shell road was crossed in two places by this line, and a considerable amount of shells was necessarily removed.

Chalmette cemetery section is a new levee. It connects the Chalmette Cemetery and Deboushel levees of 1892-'93. This section of levee runs immediately in front of the "National cemetery Chalmette," and its construction necessitated the removing of a portion of the iron fence in front of the cemetery together with 12 linear feet of the brick wall on lower boundary, and the rebuilding of 96 linear feet of the iron fence on a line about, an average of, 8 feet farther back. The removing and rebuilding of this fence was done under separate contract at a cost, to the United States, of $95. Permission to remove the fence was obtained from the Quartermaster-General, approved by the Secretary of War, through the Chief of Engineers, on September 12, 1893.

Mercier section is a new levee. It begins at the lower end of the Deboushel levee of 1892-'93, and extends downstream 1,200 feet connecting at its lower end with an old levee recently repaired by local authorities.

The completion of embankment in these sections makes a continuous line of United States levee, all revetted, from the upper end of Slaughter House extension section to the lower end of Mercier section of Battle Ground levee, a distance of about 11 miles.

Irving levee (975 L).—This levee consists of 983 linear feet of enlargement and 4,575 linear feet of new levee. It commences at the lower end of Story lower levee of 1892-'93, and extends down to the upper end of the State dike across the Lake Borgne Canal. The old levee abandoned by this line is of inferior section and height and too near the river bank to have justified enlargement. A portion of this old levee was used in construction of the new one.

Carnarvon levee (978.5 L).—This is a new levee which was staked out in October, 1892, but was not built during that season for the lack of funds.

Much trouble has been experienced in the construction of this levee.

That portion of embankment extending from station 13 to station 17 commenced to sink, or slough, on January 4, 1894, when earth had been placed to a height of about 4 feet below gross grade. This levee line runs through field and land which was occupied by negro cabins, and just back of where were found the remains of an old sugar mill. The land occupied by the sinking portion of embankment was grown with Bermuda grass and was seemingly similar to that found along the lower coast generally, there being nothing to indicate unstability of foundation.

After sinking had been discovered a careful inspection of vicinity was made, but no evidence of the former existence of any artificial or natural drain was discovered. There was an old pond to river side of embankment between station 10 and station 11+15, a portion of which was filled to obtain required berm. This pond is supposed to have been used to supply water to sugar-house, remains of which were above mentioned. The citizens of this section of country have been questioned, and, as well as can be learned, there was at one time a crevasse in this vicinity, though its exact location can not be given. It is supposed to have occurred between the years 1840 and 1850.

Work on this levee was commenced with wheel-scrapers, but on January 26, 1894, wheelbarrows were substituted.

This latter force continued work, making little progress toward satisfactory completion, until March 27, when all work was seemingly abandoned by contractor's force.

Owing to the continued sinking of embankment and probability of higher stage of river a quarter boat with wheelbarrow force was sent to this levee by the United States March 30, 1894. This United States force continued work on the sinking portion (station 10 to station 13+15, only) until April 20, when crown of embankment was raised to about net grade. This being about 6 feet above level of water in river on that date, and rate of sinking small, it was considered practically safe for the present and work was discontinued. Quarter boat was returned to Government depot and force dismissed.

Embankment from station 10+50 to station 12+50 shows slight sinking since April 20, but with present stage of river little trouble may be expected. However, should the river reach a stage approximating the extreme high water of last season, additional work will no doubt be necessary.

Orange Grove levee (979.5 L).—This levee consists of two sections, upper and lower. The upper section connects the Orange Grove upper and lower levees of 1892–'93. The lower section begins at the lower end of Orange Grove lower of 1892–'93, and extends downstream a distance of 743 feet, connecting with a levee of good section and height recently built by local authorities. Both sections are new levees.

English Turn (981 L).—This is a new levee which was completed before date of last annual report, but paid for out of allotment for this year. Old levee abandoned by this line is of inferior section and height, and very near caving bank.

St. Clair levee (982 L).—This levee consists of 4,054 linear feet of enlargement and 3,023 feet of new levee.

It connects English Turn and Mon Plaisir levees of this year. That portion of old levee to river side of new line, between station 8 and station 29 + 15, was abandoned owing to improper alignment and the existence of numerous crayfish leaks. The portion of old levee abandoned by the lower portion of new line was too near river bank to justify enlargement.

Mon Plaisir levee (983 L).—This is a new levee joining at its upper end the lower end of St. Clair levee and at its lower end with a new levee called "Scarsdale," built this season by local authorities. The old levee abandoned by this line was of inferior section and height and too near river bank to justify enlargement. Portions of the old levee used in construction of the new.

REPAIRS.

Levees 1892–'93.—On July 31, 1893, quarter boat "C" was prepared for work of repairing such damages as had been done to levees during high water of 1893, and on August 1 it was towed to Slaughter House levee (968 L). On August 2 decked barge No. 16 from New Orleans Harbor was towed to same place with additional tools and material. This force, with master laborer in immediate charge, floated from point to point, and, with few exceptions, was towed only when necessary to cross the river.

This method of transporting quarter boat and barge would, however, be at some seasons of the year impossible owing to varying high winds, but when small force is employed and time is no object the cheapness of this plan would recommend it notwithstanding the difficulties usually encountered.

Work accomplished by this force is as follows:

Wire fence at Slaughter House extension levee was repaired. Revetment repaired and slopes washed by waves restored at Roy, Bonzano, Chalmette cemetery, Deboushel, Story upper and Story lower levees. Crayfish leaks cut out, cut refilled, and earth tamped at Pecan Grove and Story upper levees. Line of tile drains found under lower end of Story lower levee cut out, cut refilled, and earth tamped. Borrow pits drained at Pecan Grove, Story lower, Orange Grove upper and English Turn levees. Where weeds had grown on levees they were cleared off, and where sediment had choked tile-drain outlets it was removed.

BARATARIA DISTRICT.

Construction—Magnolia levee (979 R).—This consists of two sections of new levee. The upper section is 2,500 feet long, and connects the upper and lower sections of the Magnolia levee of 1892–'93. In the construction of this section it was found advisable to abandon about 410 feet of the upper portion of Magnolia lower section of 1892–'93 owing to its being near a washing bank, and to the existence of a large leak, caused by crayfish or muskrats. The comparatively new revetment on abandoned portion of United States levee was removed and rebuilt on the lower portion of the upper section 1893–'94, being 414.6 linear feet. This was done under separate contract for 25 cents per linear foot.

The lower section of this year connects the Magnolia lower section and Fort St. Leon upper levees of 1892–'93.

Fort St. Leon middle levee (980.5 R).—This consists of 2,134 linear feet of new levee and 1,656 feet of enlargement, and connects the Fort St. Leon upper and lower levees of 1892–'93.

Belle Chasse levee (981.5 R).—This consists of 5,008 linear feet of new levee, and 693 feet of enlargement. It connects the Fort St. Leon lower and Belle Chasse crevasse levees of 1892–'93. The old levee abandoned was too near the river bank to justify enlargement, about 100 feet caved into the river during construction of the new levee.

Kearney levee (982.5 R).—This is a new levee beginning at a point 1,251 feet below the Belle Chasse crevasse levee of 1892–'93, and extending downstream it joins at its lower end a new levee built this season by local authorities.

St. Anne levee (994 R).—This is enlargement of an old levee, and connects the middle and lower sections of the Belle Chasse to Concession levee of 1892–'93.

Oakville levee (990 R).—This is a new levee built back of an old and insufficient embankment which was too near the river bank to justify enlargement. The old levee abandoned was used in construction of the new.

Star levee (995.5 R).—This levee consists of 520 linear feet of new levee and 2,668 feet of enlargement. That portion enlarged had been badly washed by waves, and was of inferior section and height. The portion of old levee abandoned was leaky, and had caused much uneasiness during high water of 1893. It was used in construction of the new levee.

Ironton (999.7 R).—This is enlargement of an old levee of good height but inferior section, and badly wave-washed.

Myrtle Grove (1,002.3 R).—This is a new levee built back of an old and insufficient embankment which is immediately on the river bank. Cuts were made through old levee to drain borrow pits; otherwise it remains undisturbed.

Oakland levee (1,003.2 R).—This levee consists of 444 linear feet of enlargement and 756 feet of new levee. The old levee was abandoned owing to improper alignment and to the existence of many leaks, which gave considerable trouble during high water of 1893. It was used in the construction of the new levee.

Deer Range levee (1,004 R).—This is a new levee built back of an old embankment of very low grade and inferior section. The old levee was used in constructing the new.

This levee was built instead of the Dobard levee (992.5 R), which was not considered necessary this season, under the same contract and the same price per cubic yard. Supplemental articles of agreement November 25, 1893.

REPAIRS.

Levees of 1892-'93. The same quarter boat, barge, and force as in the Lake Borgne district was used in this.

Work accomplished as follows:

Crayfish leaks cut out, cuts refilled, and earth tamped at Magnolia lower section and Belle Chasse crevasse levees. Revetment repaired on Belle Chasse to Concession middle section. Slopes, where washed, restored at Bello Chasse to Concession upper section and Happy Point. Pits drained at Fort St. Leon lower, Belle Chasse crevasse and Happy Point levees. Where weeds had grown on levees they were cleared off, and where sediment had choked tile-drain outlets it was removed.

The quarter boat was kept in service until September 18, 1893, when it was returned to Government depot, and on September 19 barge No. 16 was turned over to New Orleans harbor.

REVETMENT.

Where revetment was built the following plan was adopted: The facing was made of planks 1¼ inches thick, width being from 6 to 18 inches, and sufficiently long to be driven not less than 6 inches below the original surface of ground.

These planks were nailed to two rails 2 by 6 inches by 18 feet, one flush with and one 4 feet below top of facing.

These rails were nailed to 3 by 4 inch posts which projected 6 inches above and 6 inches below the facing planks. Posts were driven 9 feet apart in the river slope of levee at a distance of 12 feet from center line. These posts have each one brace, 2 by 6 inches by 13 feet, which extends 6 inches over top of revetment and notched to fit down over top of revetment, thereby giving more strength to resist pressure from river side. The braces were nailed to posts, the upper surface of brace being about 1 inch below top of post. The other end of brace was nailed to three stakes placed as follows: One, 2 by 6 inches by 3 feet, driven 1 foot to land side of river edge of crown; one, 3 by 4 inches by 3 feet, driven in center of crown of levee and on opposite side of brace to stake first mentioned; one, 3 by 4 inches by 3 inches, driven 1 foot to land side of center line of levee and at end of brace as a butting stake, in order that any jar received by revetment from floating logs, etc., might not be thrown entirely upon nails on the other two stakes. After posts, rails, and facing had been put in place an additional rail 2 by 6 inches was nailed on outside of and flush with top of facing to prevent planks forming the same being easily removed.

Nails used in securing braces to posts and stakes and rails to posts were 6-inch wire nails; those used in securing facing to rails were 4½-inch wire nails. Lumber used was sound heart cypress, free from shakes, sap, loose knots, or other serious defects. Sound "pecky" lumber permitted if peck did not go entirely through.

Plan of construction.—A trench was dug in river slope of levee 12 feet from center line to within 18 inches of full depth of facing.

The side of trench against which revetment was to rest was made straight and of proper slope—*i. e.*, 1 to 8.

Posts were put in place and driven 2 feet into earth which had not been disturbed. After the two rails were nailed to posts the planks for facing were driven and nailed

and the outer rail nailed on, the braces were nailed in place, all projecting points of nails clinched, and trench refilled with earth thoroughly tamped.

HIGH-WATER PROTECTION.

At date of this report the river reached a stage of 13.4 feet at New Orleans, 4.5 feet below the highest previous record.

LAKE BORGNE DISTRICT.

Defects in levees so far developed are as follows:

Slaughter house, 1892–'93 (968.5 L).—Slight wave wash inside of revetment at station 0 plus 40.

Slaughter-house extension section of the Battle Ground levee (969.5 L). Wave wash inside of revetment. This has been arrested. Cost of labor, $11.

Roy levee, 1892–'93 (969 L).—Wave wash inside of revetment station 0 to 0 plus 40; has been arrested. Cost of labor, $5.

All other United States levees in this district are in good condition.

There is a large crayfish leak in old levee on Caernarvon plantation, which is being worked on by local authorities. Local boards have inspected along line of levee from Slaughter House (968.5 L) to Point a la Hache (1010 L).

BARATARIA DISTRICT.

Defects in levees so far developed are as follows: Belle Chasse levee (981.5 R). Some seepage along toe of land slope from station 2 to station 9.

Deer range levee (1004 R).—Slight wave wash at station 3 to station 4.

All other United States levees in this district are in good condition.

Local boards have inspectors along line of levee from Magnolia plantation (978.2 R) to the Socola Canal (1015.1 R).

LEVEES 1894–'95, LAKE BORGNE DISTRICT.

Construction of 1894–'95 levees in this district has not been commenced.

Levees as now contemplated are as follows: Sugar House (970.6 L). This will be a new levee 1,280 feet long. Contract awarded to I. R. Bobbit, for 14¼ cents per cubic yard. Date of contract, December 1, 1893.

Merritt (976 L).—This levee will consist of two sections. The upper section is to be a new levee commencing at a point about 660 feet below the Lake Borgne Canal, and extending downstream for a distance of 1,424 feet, connecting with the upper end of the Merritts crevasse levee built by local authorities during the season of 1892–'93. The lower section consists of 1,593 feet of enlargement, and 1,197 feet of new levee.

It will commence at the lower end of the Merritts crevasse levee just mentioned, and extend down to join the United States Repose levee 1892–'93. Contract awarded John Mahoney for 13.85 cents per cubic yard. Date of contract, December 1, 1893.

Poydras (977.4 L).—This is to be a new levee 3,037 feet long, back of an existing levee which is threatened by caving bank.

Caernarvon upper (978 L).—This will be a new levee 1,403 feet long, back of an old levee in which there are many crayfish leaks.

Stella (986 L).—This will consist of 825 feet of enlargement and 2,633 feet of new levee. There was an old levee in front of this proposed line which washed away during flood of 1893, and water was held out by another smaller levee to the rear. A portion of this rear levee is intended to be enlarged, and a portion will be back of the new line. Contract for construction of new levee awarded Jeffries & Dameron for 13 cents per cubic yard. Date of contract, December 1, 1893.

Greenwood (990 L).—This is to be a new levee 3,009 feet long. The front levee to be abandoned by this line is threatened in many places by caving bank.

Contract for construction of the new levee was awarded Donovan, Daley & Co. for 12.90 cents per cubic yard for embankment, and 10 cents per cubic yard for filled excavations. Date of contract, January 28, 1894.

Remark.—The foregoing is of levees as now contemplated. However, after the present flood season shall have passed, the conditions may be changed, necessitating the modification or abandonment of some of these lines.

LEVEES 1894–'95, BARATARIA DISTRICT.

Construction of 1894–'95 levees in this district has not been commenced.

Levees as now contemplated are as follows: Kearney upper (982.2 R). This is to be a new line 1,243 feet long, connecting Belle Chasse crevasse levee 1892–'93, and Kearney levee 1893–'94.

Kearney lower (983.1 R).—This is to be a new levee 1,081 feet long, connecting the upper and middle sections of Belle Chasse to Concession levee 1892–'93.

A portion of the middle section will have to be abandoned owing to caving bank.

Live Oak upper (991.8 R).—This is to be a new levee 870 feet long, connecting the upper and lower sections of the Live Oak levee of 1892–'93.

La Rose (1003.4 R).—This is to consist of 620 feet of enlargement and 1,241 feet of new levee. It will begin at the lower end of the Oakland levee 1893–'94 and extend downstream, connecting with the upper back angle of levee recently built by local authorities.

Purcell (1003.8 R).—This is to be a new levee beginning at a point 900 feet below the lower end of the proposed La Rose line and extending downstream a distance of 1,976 feet, connecting with the Deer Range levee 1893–'94.

Remarks.—The following is of levees as now contemplated. However, after present flood season shall have passed, the conditions may be changed necessitating the modification or abandonment of some of these lines.

SUMMARY.

Lake Borgne district.—The completion of 1893–'94 work makes in this district total length of United States lines 8.67 miles, aggregating 372,597.68 cubic yards of earth and 17,479.5 linear feet of revetment.

Lost by caving and abandonment from May 1, 1893, to May 1, 1894, 89,637 cubic yards.

The line of levee from Point a la Hache to Fort St. Philip was badly damaged by the storm of October 1 and 2, 1893, and while some repairs have been made by farmers and police jury of Plaquemine Parish, there is still much work necessary to obtain a safe line of levee.

Barataria district.—The completion of 1893–'94 work makes in this district total length of United States levees 10.62 miles, aggregating 356,692.91 cubic yards of earth and 22,929.5 linear feet of revetment.

Lost by caving or abandonment from May 1, 1893, to May 1, 1894, 89,693 cubic yards of earth.

The line of levee from a point about 2 miles below the Socola Canal down to Fort Jackson sustained much injury from the storm of October 1 and 2, 1893, being in many places entirely washed away. The damage has been partially repaired by farmers along the line, assisted by a trivial appropriation of the police jury of Plaquemine Parish. But as crops were a total loss the farmers are so impoverished that any appreciable outlay on their part for extensive repairs was impossible. Nearly all of the levees in this stretch are small and insufficient, and located immediately on the river bank.

Very respectfully, your obedient servant,

J. SMYTH, JR.,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

HIGH WATER OF 1893.

The following table shows the data and reading of the high-water mark at each of the regular gauges in this district for the four successive floods of 1890, 1891, 1892, and 1893:

Gauges.	1890.		1891.		1892.		1893.	
	Reading.	Date.	Reading.	Date.	Reading.	Date.	Reading.	Date.
Vicksburg	49.05	Apr. 24-25	48.10	Apr. 4	48.40	June 4	48.30	May 22-23.
St. Joseph	45.15	Apr. 23	43.80	Apr. 11	44.55	June 3	43.95	May 20.
Natchez	48.60	....do	46.50	Apr. 12	48.10	June 26	46.80	May 22.
Red River Landing	48.80	....do	45.48	Apr. 27	48.87	June 27	47.72	June 25.
Barbres	49.70	....do	45.65	Apr. 25	49.70	June 28	48.70	June 26.
Bayou Sara	41.20	Apr. 21	38.80	Apr. 30	42.25	....do	41.50	June 24.
Baton Rouge	36.60	Apr. 21-22	35.55	May 5	38.45	...do	38.40	June 22.
Plaquemine	31.90	Apr. 22	31.05	Apr. 15	33.70	June 13	33.75	Do.
Donaldsonville	.....	.....	.....	.....	30.15	...do	30.60	Do.
College Point	23.90	Mar. 16	23.45	Mar. 16	25.45	June 12	26	Do.
Carrollton	16.10	Mar. 17	16	...do	17.25	June 13	17.45	June 22.
New Orleans	16.70	Mar. 21	16.40	Mar. 17	17.60	June 11	17.90	June 24.
Fort Jackson	.....	.....	6.70	Mar. 31	6.85	June 13	6.70	June 15.

It will be observed that below Baton Rouge the water was highest in 1893, and for this portion of the river it exceeded all previous records.

Above Baton Rouge the river has several times reached a higher flood plane than it did in 1893.

Besides its excessive height in the lower, river the flood of 1893 was remarkable for its lateness, its long duration, and in the effects of the Rescue crevasse. There was a nearer approximation to the conditions which may be expected when the levee system shall be completed than has ever before occurred.

No break took place in any United States levee, and the crevasses that did occur were all below Baton Rouge. The only crevasse that was not closed was the Rescue.

Particulars of the crevasses are given in the following table:

Crevasse table.

Name of crevasse.	Below Cairo.	Occurrence.		Closed.		Maximum width of break.	Cribbing.	
		Date.	Hour.	Date.	Hour.		Length of.	Width of.
Pontchartrain levee district.	*Miles.*					*Feet.*	*Feet.*	*Feet.*
McCullom	834.5	June 13	11 p. m.	June 14	8 p. m.	68	239	27
Rescue	874	June 23	10:30 a. m.			1,247		
Uncle Sam	901	June 18	11:30 p. m.	June 20	1 a. m.	40	235	25
Reserve	921	...do....	7 p. m.	June 21	6 p. m.	128	260	32
Lake Borgne levee district								
St. Clair	962	June 14	12 m	June 15	11 a. m.	10	10	6
Harlem	1,003	June 18	4 p. m.	June 30	2 p. m.	187	1,082	6
Pierre Cossé	1,013	June 20	9 a. m.	June 20	5 p. m.	12	20	4
Barataria levee district.								
Magnolia	979	June 15	9 a. m.	June 25	6 a. m.	18	100	5
Bartholemy	1,014	June 14	12 m	June 15	6 p. m.	15	*12	*5

* Mud box.

Name of crevasse.	Depth of water around cribbing.			Cause of break.	Estimated maximum discharge, cubic feet per second.	Approximate cost of closure.
	Maximum.	Minimum.	Mean.			
Pontchartrain levee district.	*Feet.*	*Feet.*	*Feet.*			
McCullom	5	3.5	4.5	Crayfish leak	3,366	$2,300
Rescue				Wave wash	132,000	
Uncle Sam	5.2	3.9	4.5	Unknown	1,980	1,750
Reserve	12.5	8.5	10.4	Refilled crayfish leak.	14,641	16,000
Lake Borgne levee district.						
St. Clair	6.5	2	4.5	Crayfish leak	350	50
Harlem	8	3	5	Rice flume	8,050	4,300
Pierre Cossé	5	2	4	Leak	335	40
Barataria levee district.						
Magnolia	5	3	4.5	Crayfish leak	430	100
Bartholemy	6	4	5.2	Rice flume	400	30

The work done by this office to assist in maintaining the levees consisted in furnishing and delivering sacks, lumber, and nails, and in moving material with the boats and barges of the district.

The successful closing of the Reserve crevasse was the most remarkable piece of work of its kind that has ever been accomplished in this district.

The following table gives details of condition, etc., of all United States levees in this district during the flood of 1893:

Name of levee.	Below Cairo.	Bank.	Height above extreme flood.	Depth of water against levee.	Time water stood against levee.	Conditions.
Lower Tensas district.						
	Miles.		*Feet.*	*Feet.*	*Days.*	
Bedford	606	R.	2.8	3 to 13	71	Fair; considerable seepage.
Hard Times-Wilson	631	R.	3	5 to 17	77	Bad; a great number of sand boils.
Hard Times	633	R.	2.8	4 to 900	77	Good; no weakness developed.
Evergreen	636	R.	1.5	2 to 9	68	Apparently good; grown up with weeds, etc.
Hardscrabble, upper (old)	638.5	R.	1.5	7 to 9	68	Good; no weakness developed.
Hardscrabble (new)	639	R.	3	8 to 9	68	Do.
Bondurant (old)	642	R.	1.7	4 to 10	71	Fair; considerable seepage.
Bondurant (new)	643.5	R.	3.8	0 to 9.7	65	Fair; badly washed, tendency to slough.
Kempe (whole line)	658	R.	2	2 to 19	79	Good; sand boils did not run.
Gibsons Landing	683.5	R.	5	4 to 22	87	Good; no weakness developed.
Lake Concordia (whole line)	700	R.	3.8	1 to 27	94	Good; a few leaks and injured by wave wash.
Arnauldia	702	R.	3.5	1 to 1.5	51	Apparently good; grown with weeds.
Henderson	713	R.	4.5	8 to 10	83	Good; no weakness developed.
Deer Park	722.5	R.	4	4 to 8	78	Do.
Green to Fairview	724	R.	1.5	4 to 12	90	Fair; seepage and wave wash at lower end.
Atchafalaya district.						
Barroza	823	R.	3.3	14	60	Good; tile drains need cleaning.
Belair	828	R.	2.8	8.8	60	Good.
Eliza	842	R.	2.1	9.0	60	Do.
Medora	852	R.	2.4	10.1	60	Good; slightly wave washed
Fortville, lower	855	R.	2	9.3	60	Good.
Lafourche district.						
Buena Vista Minnie	896	R.	2.1	9.3	60	Good.
Jamestown	997	R.	1.5	8.7	60	Do.
St. James Church	901	.....	1.7	7.9	60	Good; slightly rain washed.
St. James Estate	902.5	R.	1.7	7.3	60	Do.
Home Place	905.5	R.	2.2	9.3	60	Good.
Flagtown	936.5	R.	2.2	5.1	60	Do.
Lone Star	941.5	R.	2.5	7.6	60	Do.
Davis	943	R.	2.5	11.5	60	Good; grown with weeds; irregular in section, due to wheelbarrow work.
Pontchartrain district.						
Lopez	844.5	L.	3.5	6.5	60	Good; irregular in section, due to wheelbarrow work.
Burtville	847	L.	3	10.2	60	Good; slightly rain and wave washed.
Towles	851	L.	2.3	7.2	60	Good; irregular in section, due to wheelbarrow work.
Billings	852.3	L.	2.2	7.1	60	Good.
Jolisant	858.8	.....	2.3	7.7	60	Good; very irregular in height and section, due to wave wash.
Oakley to St. Gabriel	862	L.	2.3	8.5	60	Good; very slightly rain washed.
Dicharry, lower	883	L.	1.3	9.3	60	Good.
Burnside	891	L.	1.9	7.1	60	Do.
Union, upper	893	L.	1.6	7.4	60	Do.
Union, lower	893	L.	1.7	6.8	60	Do.
Tippecanoe	894	L.	1.6	6.7	60	Good; slightly rain and wave washed.
Peytavin	894.5	L.	1.6	5.6	60	Do.
Whitehall	895	L.	2.1	4.9	60	Good; slightly rain washed.
Tessier	909.5	.....	1.9	10.1	60	Good.
St. Elmo	910	L.	2	9.3	60	Do.
Poche	911	L.	2.2	6.2	60	Do.
Hope	916.5	L.	1.7	7.9	60	Good; slightly wave washed and worn from travel over it.

Name of levee.	Below Cairo.	Bank.	Height above extreme flood.	Depth of water against levee.	Time water stood against levee.	Conditions.
Barataria district.						
	Miles.		*Feet.*	*Feet.*	*Days.*	
agnolia	980.5	R.	3	5	84	Fair; one crayfish leak.
ort St. Leon, upper	981.5	R.	3	5.5	84	Good; no weakness.
ort St. Leon, lower	982.5	R.	2.8	3.7	71	Do.
elle Chasse Crevasse	983	R.	2.6	5.8	88	Fair; one crayfish leak.
elle Chasse to Concession	985	R.	3	5	84	Good; slight wave wash.
oncord	987	R.	2.6	5.5	87	Good; no weakness.
ak Point	988.5	R.	2.3	3.4	67	Do.
ive Oak	990.5	R.	2.7	4.3	69	Do.
appy Point	991.5	R.	2.7	5	79	Good; slight wave wash.
Lake Borgne district.						
aughter House	968.5	L.	2.5	3.6	67	Good; no weakness.
aughter House, extension	968.5	L.	1.5	5	75	Fair; wave washed and too low for about 1,700 feet.
oy	969	L.	3	5	75	Fair; slight wave wash.
unzano	969	L.	2.8	3.1	63	Good; no weakness.
almette Cemetery	969.5	L.	2.5	3.4	64	Do.
aboushell	970	L.	2.5	3.6	67	Do.
can Grove	973	L.	2.8	4.2	72	Fair; seepage; one crayfish leak and 2 sloughs.
ory, upper	974	L.	2.8	4	61	Fair; slight wave wash.
ory, lower	975	L.	2.8	5	61	Good; some seepage.
pose	976	L.	2.9	4.5	61	Fair; wave wash.
ange Grove, upper	980	L.	1.5	6	86	Good; slight seepage.
ange Grove, lower	980	L.	2.5	5	86	Do.
glish Turn	981.5	.....	4.5	4.5	30	Good; no weakness.

The report of Assistant Engineer H. S. Douglas, in local charge of the Lower ensas district, is as follows:

NATCHEZ, MISS., *August 23, 1893.*

SIR: I have the honor to submit the following report on the high-water protection levees, Lower Tensas district, during the high water of 1893, with comparative ood heights at different points; condition of levees when under strain, effectiveness tile drains, etc.

The overflow of lands behind the levees has been extensive and the damage ually large, although no crevasses occurred in the district. The lateness of the ason when the overflow occurred, more than its extent, has been the cause of the eat injury.

The inundation was general, even as late as July 1, rendering it practically impossible to produce anything on the overflowed lands. The flood was, in a certain nse, unexpected. In the early part of March the river had risen to 42.4 on the icksburg gauge and then had commenced to fall rapidly. None of the tributaries ere at a very high stage and there was a fair prospect that the levees would not be ought under any strain.

The river continued to fall until April 17, when it read 30.0 on the Vicksburg uge. On April 16 and 17 an unusually rapid and simultaneous rise occurred from iro to Helena, the rise in the forty-eight hours being 5.5 at Cairo, 6.0 at Memphis, d 5.1 at Helena. On the next day, April 18, the river commenced rising at Vicksrg. Heavy and continued rains occurred throughout the Mississippi Valley, and May 10, the Vicksburg gauge having reached 46.2, preparations for high water otection of levees were commenced. By May 15 the following plant had been sembled at Natchez: Steamer *General Newton*, steamer *Thomas B. Florence*, a pile iver, and large barge. The quarter boat *New Orleans* had been in laying-up quarrs at Natchez, and having on board a complete levee outfit was ready for service. cks were on hand and timber was purchased and put on board the plant.

Although to the extent of available funds preparation for a stubborn fight had en made, but little actual work was necessary. On May 11 the levee a short stance below Lakeport, Ark., had broken, and was followed by other breaks in at vicinity. On May 23 the levee at Wylys, a short distance below the town of ke Providence, La., gave way, causing the most disastrous crevasse of the season. a result of these crevasses, on May 24 a gradual fall commenced along the line of rees in the Lower Tensas district, and the necessity for protection work became s each day. By June 1 all work had ceased, but the levees were patrolled under rection of the local authorities as long as they were under any strain.

On May 21 the steamer *General Newton* left the district, and on June 1 the steamer *omas B. Florence* was returned to Capt. J. H. Willard, Corps of Engineers, U. S.

Army, at Vicksburg. The quarter boat *New Orleans* was returned to laying-up quarters on the same date, and the pile-driver and barge were taken to the lower district on June 5.

The high-water protection work on the levees was as follows: At Hardscrabble (641 R) the new levee had been completed, but at one point had sloughed and settled so that it was not considered safe to let the water come against it. The old levee was still unbroken in front, but had been cut down to within two-tenths of a foot of the high-water mark of 1892 for a distance of about 400 feet. The local authorities raised this low stretch to the general grade of the old levee. Although as matters turned out the work was not required, it was a wise precaution.

At Rifle Point (690 R) the existing levee is full of holes, attributed to crayfish. One of these holes attained a dangerous size and commenced to discharge lumps of clay washed out by the current. The local authorities temporarily closed the hole by building a loop or horseshoe around it.

On the line of levees around Lake Concordia, comprising Grassmere to Wiccma (692 R), Wiccema to Fletcher (693 R), Fletcher to Minorca (699 R), and Minorca to Minors (702 R) the United States furnished all labor and material. On May 17 the steamer *Thomas B. Florence* with a pile-driver in tow went into Lake Concordia and remained on duty there until May 29. The levee generally was in excellent condition as compared with former years and gave but little cause for apprehension. Some of the old levee that had not been raised and enlarged had to be extensively repaired with sacks of earth, the wave wash of previous years having almost destroyed the river slope. As the new embankment had not had time to sod it washed badly in places where exposed, and in some cases had to be sacked as a precautionary measure. About 5,000 sacks were used. A few leaks developed in some of the bayous, and an endeavor was made to close them with sheet piling driven on the river side.

The experiment was only partially successful, as the holes were either below the level reached by the piles or the inlet was some distance up or down the levee from a point opposite the outlet. About 15,000 feet, B. M., lumber was used in sheet piling.

Where the tile drains had been completed the benefit was decided. The foot of the land slope and the ground in the immediate rear of the levee remained dry and hard, while at other points, where there were no tile, the public road in the rear of the levee became impassable from seepage water.

From Lake Concordia levee to the lower end of the district no protection work was required.

During the period of high water inspections of the different levees were made, and the results are consolidated in the following table:

High-water marks were established at different points throughout the district. The following table gives comparative elevations of high water of 1893 and previous years at the several points so far determined. Elevations are referred to the Memphis datum plane:

Place.	Below Cairo.	1890.	1891.	1892.	1893.
	Miles.				
Vicksburg	599.3	102.0	101	101.3	101.2
Bedfords	606.5	99.4	.....	98.6	98.4
New Carthage, Lake Palmyra	619	94.1	92.9	.....	92.80
Burn Landing, Lake Palmyra	625	93.9	92.65	.....	92.60
Hard Times	633	89.65	88.15	88.9	88.2
Bondurant	643.5	86.8	.....	85.6	85.2
St. Joseph	648.3	84.8	83.4	84.2	83.7
Beelers Landing	655	.....	80.2	81	80.9
Goldmans Landing	659.5	80.7	79.3	79.8	79.5
Gibsons Landing	683	78.5	76.7	.....	76.9
Good Hope	691	76.3	.....	75.2	74.2
Wiccema, Lake Concordia	692	75	.....	.....	73.5
Ferridays, Lake Concordia	693	75.1	.....	.....	73.7
Minorca, Lake Concordia	695	74.9	73.2	.....	73.4
Minors, Lake Concordia	697.5	.....	.....	.....	71.6
Vidalia	700.7	71.7	.....	71.45	71
Natchez	700.3	72.40	70.3	71.9	70.6
Greens	721	67.6	.....	67.5	66.2
Fairview	729	66.2	.....	65.62	64.70
Red River Landing	765.3	59.5	56.20	59.60	58.4

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer W. J. Hardee, in local charge of the Atchafalaya, Lafourche, and Pontchartrain levee districts, is as follows:

BATON ROUGE, LA., *July 27, 1893.*

SIR: I have the honor to submit the following report on high water and protection of levees for flood of May and June, 1893:

PROTECTION ORGANIZATION.

As early as May 10 the river was rising steadily and the conditions of the upper river and tributaries justified the opinion that extreme high-water limits would be reached on the lower river.

The tug *Comstock* was assigned to duty under my direction for service during the flood. For a short while the *General Newton* was also put under my direction.

Large decked barges, belonging to Fourth District works, were stationed at Bayou Sara, Baton Rouge, Plaquemine, Donaldsonville, and Lutcher to render assistance in transporting material for the local authorities as well as for general use, under direction of this office.

Later on empty sacks, and at still later date lumber, was loaded on these barges, to be held for emergency calls.

In the meantime a constant patrol was made, either personally or by inspectors under my direction, of the levees between Red River Landing and New Orleans. The details of such inspection will be found in report by districts.

IN GENERAL.

Experiences and comparisons.—As compared with the flood of 1892, the high water of 1893 was 0.7 feet lower at Bayou Sara, practically the same height at Baton Rouge, 0.05 feet higher at Plaquemine, 0.40 feet higher at Donaldsonville, 0.65 feet higher at College Point, and 0.02 feet higher at Carrollton.

The efficiency of the levee system, taken as a basis of comparison, the flood of 1893 was by far more dangerous than that of 1892.

In the 75-mile stretch from Red River Landing to Baton Rouge, where the water was lower, the levees are in splendid condition, some few short lengths of levee excepted, and the line as a whole was in condition to have easily stood an average of 2 feet more water than was experienced.

Since the flood of 1890 the Atchafalaya levee board, with the assistance received from the Federal Government, has well nigh perfected the levee line on this stretch of river, the embankments having high grades and large sections.

Between Baton Rouge and Carrollton, a distance of about 125 miles, at some points as much as 0.7 feet more water was experienced than in 1892, and it was in this length of river that the levees were in less condition to withstand the increase.

There are many miles of low grade levees, levees that have very narrow crowns, small base, and very steep slopes. It was only by diligent work and careful watching that such levees were made to hold the excessive flood of 1893.

Above Baton Rouge there are no levees with grades lower than the flood of 1893.

Between Baton Rouge and Barroza there are several lengths of levee, aggregating probably as much as 2¼ miles, which were topped to meet the flood of 1892.

Nothing beyond board revetting was done on these levees as the "topping" of the previous year afforded sufficient increase in the way of height.

From Barroza to Red River all the levees are high and neither the flood of 1892 or 1893 came near their tops.

The tabulated statements contain no notice of levees, the grades of which were only a few tenths above the surface of the river. Probably as many as 4 miles in the Atchafalaya district, 3 miles in the Lafourche district, and 10 miles in the Pontchartrain district of these low levees exist, and as the river was rising and in anticipation of a higher stage of water they were planked and topped to meet the increase.

The amount a levee was low as expressed in the tables, refers to its average elevation below the flood surface. In some localities the surface of the levee is of such irregular elevation that the minimum and maximum of low elevation is given.

A much more comprehensive idea of this subject may be obtained by securing from the State engineers their continuous levee profiles for the three districts. On these could be located the grades for lengths of new levee recently constructed by the United States.

By platting on these profiles the flood surface of the river, as determined by the high-water elevations ascertained by this office, at a glance the different classes of low levees can be appreciated—those that were far below the flood height and those varying from equal elevation to standard grade.

Without intending to attempt a discussion of the effect of crevasses on the slope of the river, it would appear manifest that the crevasses at Belmont, Anchor, and

Sarpy did depress the height of the river on either side of each, for, with a similar stage of water at Baton Rouge and practically the same elevation at Carrollton this year as in 1892, we observe the river averaging 0.6 higher in the vicinity of the crevasses in 1893 than in 1892, which can only be interpreted as a restoration of the normal surface of the river which those crevasses had disturbed.

In spite of the excessive height of water this year, the levees proved more efficient than ever before. Between Red River Landing and Carrollton there were only four crevasses as against nine during 1892, and only one which could not be closed, and was allowed to run, as against three during that year. The aggregate width of flowing crevasses in 1892 was 3,203 feet; the same for 1893 is only 1,220 feet.

ATCHAFALAYA LEVEE DISTRICT.

In the upper half of this district, or between Red River Landing and Baton Rouge, owing to the high grades and full sections of levees, but little protection work was necessary.

In the lower half, or between Baton Rouge and Donaldsonville, there were stretches of levee having low grade and inferior section.

Under direction of the parish commissioner of the Atchafalaya levee board, material was promptly moved to such localities, and by labor hired and paid for by that board the low levees were raised with earth and sacks and a washboard placed along the front or river side of this new work to prevent its wave-washing.

At quite a number of places bad crayfish leaks had developed, and under direction of same authority and in similar manner these places were bulkheaded and sacked until made secure.

In this district the United States levees built during the season 1892-'93 had become well sod-grown, which prevented the large amount of wave-wash which might otherwise have been expected.

Though the water stood against the embankment in this district from May 1st to July 15, a period of sixty days, none of these levees evinced a disposition to slough. Those constructed with modified land slope showed themselves strong, and by reason of the curvature of the slope sustained less rain wash than the average levees of same height and built of same class of material.

This observation was made in comparing the slopes of both sides of the same levee before the river went against the embankment and while both slopes were exposed to same conditions of weather, etc.

On the whole, the tile drains operated nicely and gave every evidence of fully accomplishing the purpose of their intention.

At some localities, owing to imperfect drainage, or in other words, lack of depth and inclination of ditches into which the outlets were made to drain, the cross drains or outlets became choked with silt washed by rains from the surface of the new embankment.

These were cleared and the main lines readily carried off the bulk of the seep water.

In addition to the work of cleaning the cross drains or outlets for tile drains, the only other work necessary and executed is described in the following statement:

Atchafalaya levee district.

Name of levee.	Below Cairo.	Sacks.	Application.
	Miles.		
Barroza, Upper	823	200	Sacking wave-wash 175 feet long.
Belle Vale	825.5	200	Sacking wave-wash 40 feet long.
Missouri	840	300	Sacking wave-wash 46 feet long.

LAFOURCHE LEVEE DISTRICT.

The service rendered by the United States in caring for levees in this district was confined to levees built by it.

Barges were held in readiness to give assistance if called for. The tug *Comstock* patrolled the front of the district, and was ready to render service if required.

There were many miles of levee having low grade, narrow crown, and steep slopes. There were also numerous crayfish and musk-rat leaks, which endangered the levees.

Under the direction of the Lafourche Basin levee board local commissioner, material was promptly moved to such localities and the necessary work done and paid for by that board to make the low and otherwise weak places secure.

The same may be said of the levees built by the United States in this district as

has been reported for the Atchafalaya levee district, both as regards length of time the water was against the embankments, their stability, and the experience with and service of the tile drains. In this district, as in the Atchafalaya, the cross drains had become choked with silt washed from the new but poorly sod-grown embankment, and they were cleaned and made to operate successfully.

The experience in this district was similar to that in the Atchafalaya district relative to the levees constructed with modified land slopes.

The amount of actual protection work done in the way of preservation of its levees by the United States was limited.

In addition to the clearing of rank growth of weeds from some of the embankments and the clearing of tile drains, the following table explains the work done:

Lafourche levee district.

Name of levee.	Below Cairo.	Material expended.			Application.
		Sacks.	Lumber (feet, B. M.).	Nails (kegs).	
	Miles.				
Jamestown	897	3,805	4,910	3	Bulkheading back slope and raising grade of lower wing 251 feet long.
St. James Church	901	480	1,410	¼	Revetment to arrest wave-wash 400 feet long.
Lone Star	941.5	250			Sacking front slope to arrest wave-wash 250 feet long.

It may be explained that the lower wing of the Jamestown levee was designed for temporary service. The main line of levee is extended downstream, under an 1894 contract, and as it was only to afford service for one year, the wing was built to a grade equal to elevation of 1892 high water, and with base and slopes correspondingly decreased.

Owing to height reached by water above 1892 flood, and the reduced base and slopes, the work designated in foregoing tabular statement was made necessary to prevent overtopping of the levee and to check the disposition of the rear slope of the embankment to slough.

PONTCHARTRAIN LEVEE DISTRICT.

This district was the worst sufferer of the three from the flood of 1893. At its upper limits the water was practically the same height as in 1892, at its lower limits about 0.2 feet higher, and throughout the central portion as much as 0.7 feet higher.

The increased height was experienced where the levees were less able to stand it. Owing to the increase many miles of levee which were barely high enough to stand the high water of 1892 had to be raised.

During last low-water season every well-known crawfish leak which had previously given trouble during floods was, under the direction and at the expense of the Pontchartrain levee board, cut out and the cut refilled with clean earth and tamped.

The majority of these cuts gave considerable trouble during the recent flood, and nearly every one required close attention and considerable work to make them secure. At some the crayfish had reappeared and cut their holes through the comparatively new or loose earth, rendering the leaks more dangerous than they were before.

The care of these places, together with the large amount of raising to keep the low levees above the water, together with the bulkheading erected at many localities to check the sloughing due to insufficient bases and steep slopes, aggregate a very large amount of work.

Owing to the impoverished condition of the Pontchartrain board's finances it was able to render but small assistance, confined principally to the furnishing of lumber and sacks, the Illinois Central and Mississippi Valley railroads and planters furnishing the labor.

The United States has a much larger mileage of levees built by it in this district than in either of the other two. These levees having been built on improved sections and high grades, the amount of work necessary to care for them was small, being confined principally to the arrest of wave wash of embankments only recently completed where the sod had not yet had time to acquire a good growth.

The tug *Comstock* and barges were used in this district, and rendered valuable assistance.

The following table explains the extent of work done and the application of material expended by the United States:

Pontchartrain levee district.

Name of levee.	Below Cairo.	Material expended.			Application.
		Sacks.	Lumber (feet, B. M.).	Nails (kegs).	
	Miles.				
Baton Rouge	833.5				Raising low levee and bulkheading crayfish leaks.
Conrads Point	840	10,720			
Lopez	844.5	1,200	3,738	1½	Revetment and sacking 501 feet of wave washing.
Burtville	847	600	2,102	½	Revetment and sacking 250 feet of wave washing.
Jolisant	858.8	1,070	4,398	¾	Revetment and sacking 541 feet of wave washing.
Rescue	874		7,550	1	Attempt to close crevasse.
Tippecanoe	894	200			Sacking to arrest wave wash.
Uncle Sam	901	800		2	Closing crevasse.
Reserve	921	1,500			Do.
Trudeau	949	300			Bulkheading drainage cut in old levee.

In addition to this an almost constant patrol of the levees was made on the *Comstock*. They were frequently inspected. In the early part of the flood season it was found that some of the tile cross drains had become choked with silt washed from the new embankments. These were cleaned and the tiles operated successfully.

The experience with the tile system of drainage was gratifying. As a whole they operated well. At the localities where they were not entirely successful the lack of success was not attributable to a lack of principle, but to the absence of good existing drainage, which is necessarily a part of the system.

It must be remembered the United States did nothing in the way of canal or ditch drainage from the tile discharges back to the swamps or low ground, but the existing drainage was depended on to afford that service. At some places the existing drainage was defective, and it was at such localities only that the tile drains were not fully successful.

Not a single United States levee in this district evinced any weakness of construction. There were no sloughs or leaks. They were, on the contrary, admirably strong, and those built with a concave or modified land slope have worn particularly well, the gentleness of the curvature affording an easy water shed. They washed less from rains than has been the experience with embankments of similar heights and built of the same class of earth.

The flood of 1893 was against these embankments from about May 15 to July 15, a period of sixty days.

The water was against these embankments within a foot of its maximum elevation for about ten days.

CREVASSES.

Four crevasses occurred in this district, of which three were closed and one was allowed to run after every effort to close it proved unavailing.

At McCullom crevasse, which was closed, there were no steamboats belonging to the United States available. Two tugs were engaged for the occasion and rendered service in moving men and material.

At Uncle Sam crevasse, which was closed, no assistance was given with boat or barge service.

At Reserve crevasse, also closed, the tug *Comstock* and barges rendered assistance in moving men and materials.

Rescue crevasse occurred at 10.30 a. m. of July 23, in a levee averaging 9 feet high, crown averaging 6.5 feet wide, river slope 3 to 1, and land slope 2½ to 1.

Immediately at the break, and for some distance above and below, the water was approximately 1.5 feet higher than the top of the levee. In order to prevent overtopping wash boards had been erected along the river edge of the crown in horizontal position and backed with loose earth about 2½ feet high and 2½ feet wide.

The customary manner of doing such top work, or raising, is to do the backing with sacks and loose earth, or in the absence of sacks to erect a double line of planking from 3 to 5 feet wide so as to form a box, as it were, to hold the loose earth.

The widths of plantations in the vicinity of Rescue are narrow, employing limited labor and forcing a much larger number of feet of levee per capita for protection work than is generally the proportion elsewhere along the river.

The general inefficient condition of levees for 5 miles above and a mile or more below the crevasse necessitated a large amount of work for the limited labor available.

Much of this work was delayed in the hope that extreme high water would not be experienced. The river continued to rise rapidly and steadily, and when it became apparent that the "topping" was absolutely necessary there was so much of it to be done and labor and material so limited that it had to be gone over hurriedly, resulting in weak and insecure work.

Just at the point where the break occurred the river was 1.8 feet higher than the crown of the levee, and this excess of water was held by three 1-inch boards, backed with a narrow width of loose earth.

This immediate section had been detailed to the manager of the Rescue plantation for patrol and care. Instead of attending to this trust it is common report that he was at a neighboring store intoxicated.

As a result of the waves beating against the boards, they became disengaged. The water soon cut through the narrow bench of earth and, running over the crown and down the land slope, commenced cutting away the levee. This had been going on for an hour or more, when some passing horsemen noticed it and gave the alarm. The origin of the crevasse as described is a matter of conjecture, but is reasonable, being based on the appearance of the break when first discovered and the absence previously of any leaks or other defects in the body of the embankment.

As hurriedly as possible laborers were moved to the spot. The levee was melting away rapidly under the force of the rushing water. When the laborers arrived the erosion had been so rapid that for lack of material they were unable to do anything.

I was wired to at Baton Rouge and reporting to you by telephone received instructions to engage a tug here and move barge of lumber from this place to the break. The *General Newton* and barges then lying at Burnside were also instructed by wire to proceed to the break.

I went to Rescue by evening train via St. Gabriel, thence by horseback, arriving at 4 p. m. The break was then about 100 feet wide with evidences of disposition to enlarge rapidly and rapid scour of the batture.

The planters had already collected some lumber and had started lines of cribbing at proper distances from the ends of the break on both upper and lower sides. A general conference was held and a thorough system of organization effected.

Spur cribs, calculated to hold the ends, were immediately built on either side, but proved of no effect. They would wash away almost as rapidly as constructed, but would be replaced as often as destroyed.

The line of cribbing as designed would have been about 700 feet long if successfully completed. This length was made necessary by the long distance back from the ends where the cribbing had been started, prompted by the rapid enlargement of the break.

At the upper side there was about 150 feet of batture and not more than 40 feet at the lower side. From soundings made by me on the outer edge of the batture it was found only 4 feet of water would have to be contended with. The cribbing was designed to swing well out toward the outside edge of the batture to secure the advantage of this shallow water (the water was about 8 feet deep in near the levee), which would also partially account for the long length of crib as designed.

I was told by old residents that in 1861 there had been a crevasse at this identical spot. The existing levee or the one in which the break occurred was then made the retired line. Between the levee and river bank deep gulches cut by that break had filled with deposit of silt and sand.

This was soon made manifest by the rapid scour of the batture. The "jump-off" or main cataract in the water which is first just at the levee was hourly moving out toward the river bank. Large logs and stumps partially embedded in the batture were becoming dislodged by the erosion about them and would float through the break.

I know from personal observation that the batture was covered with grass and weeds. The assumption is that once the surface was disturbed, the sod and weeds cut away, the light material forming the batture having no stability melted away under the terrific force of the water.

The barge of lumber from Baton Rouge arrived at 6 p. m.; the *Newton* and barges at 10 p. m. In the meantime the lumber brought to the crevasse by the planters had been sufficient to employ the forces until our boats arrived.

Everything was well organized; there was plenty of labor, material, and tools, and work progressed rapidly. By midnight about 150 feet of cribbing had been built on each side of the break. About 1 a. m. a portion of the cribbing on the lower side washed up about midway between the levee and the end of the crib where a force of 15 men were at work. The workmen barely had time to get

across the disturbed cribbing before it broke up and washed through the crevasse. A new line was immediately started farther downstream. By daylight this new line had been extended out to the channel which had cut and washed out the first line of cribbing. The velocity was so great and the water so deep that it was impossible to put down any more timbers.

I then went around the crevasse in a skiff to the upper side. Here also the forces had suspended work. The end of the crib had reached a channel that had cut in the upper side, and owing to the velocity of current and depth of water no more cribbing could be put down. It was apparent from surface of the water that a deep and wide channel had cut through the batture all the way out to the edge of the river bank immediately in front of the crevasse. The break was then about 225 feet wide.

I regarded the question of closing as hopeless. This opinion was shared by the planters, and all concluded to abandon the attempt. A few hours might have been spent in an attempt at further work. There is not a doubt but that any further effort would have proved futile and but a waste of labor and material. If the proper material and appliances had been on hand I am satisfied that by using the two sections of spurs of old levee the width of the crevasse could have been confined to 700 feet. I had no authority to use material for such purpose, and there being no one on the ground to undertake such work nothing was done.

I notified you by wire of the abandonment, collected the scattered material, and moved the barges and boats back to their respective stations.

In less than two days the work done by Alex Eltringham & Co. on their 1894 contract was entirely washed away.

After abandonment the crevasse continued to enlarge rapidly, and by June 28, or five days later, had acquired a width of 748 feet. At the present date all enlargement has ceased and the break is 1,247 feet wide. The water is falling rapidly and there is but little flow through the opening. Soundings made across the mouth of the crevasse on July 17 develop from 5.5 to 7.5 feet, an average of about 6 feet of water passing through the opening with a velocity of about 2.5 feet per second. The water was then just 9 feet lower than when the break occurred.

Shortly following the occurrence of the crevasse as the break widened the country in the rear, above and below, rapidly filled up with crevasse water. Its first disposition was to work to the rear until it met the ridges along the west bank of Bayou Francais and New River, when it took a northerly and northeasterly direction until the hill lands were met. It was then forced around the heads of those streams, and having filled the lowlands in the rear backed up toward the Mississippi River. It was fully a week after the occurrence before any water showed on the rear of the plantations 5 miles below the crevasse.

From personal inspection and observation and from data obtained from the parochial authorities the following approximate statement is compiled:

Total area overflowed	acres..	382,400
Cultivated land overflowed:		
Sugar	do...	14,932
Corn	do...	12,462
Rice	do...	2,720
Cotton	do...	9,229
Tobacco	do...	142
Total	do...	39,485
Railroad track in overflowed section	miles..	44
Track on which traffic was suspended	do...	30

Estimated damage.

Agriculture	$2,250,420
Live stock	21,500
Drainage and canals	19,300
Buildings and fences	22,000
Railroads	62,400
Total	2,385,620

Very respectfully, your obedient servant,

W. J. HARDEE,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer John Smyth, jr., in local charge of the Lake Borgne and Barataria districts, is as follows:

NEW ORLEANS, LA., *August 4, 1893.*

SIR: I have the honor to submit the following report of levees in the Lake Borgne and Barataria districts during the high water of 1893.

LAKE BORGNE DISTRICT.

UNITED STATES LEVEES.

Slaughter-house levee (988.5 L).—This levee showed no defects; revetment is in good condition, and tile drains carried off all seepage water.

Slaughter-house extension levee (968.5 L): Considerable wave wash occurred during month of June, and was arrested by placing sacks filled with earth on river slope. This wave wash was due to the temporary revetment having been damaged by waves and swells from passing steamers.

There was a slough on land slope extending to within 1 foot of land edge of crown and along slope for a distance of about 80 feet, caused by cattle tramping on the levee which had become softened by seepage water, there being no tile drains to carry it off. The levee in front of Montgomery's warehouse, which was not repaired by United States force in February, was raised about 1 foot for a distance of about 180 feet, to withstand extreme height of flood.

Roy levee (969 L).—Slight wave wash between station stakes 0 and 0 plus 75, and between 4 and 5, caused by water underwashing foot of revetment.

The planks forming revetment facing at these points, since decline of river, have been found to be about 1 foot shorter than was required; therefore they did not enter original ground. Tile drains kept land slope of levee free from seepage water during entire flood.

Bonzano levee (969 L).—This levee showed no weakness. Revetment is in good condition and effect of tile drains very satisfactory.

Chalmette Cemetery levee (969.5 L).—No defects in embankment revetment or tile drains have been discovered.

Deboushel levee (970 L).—Embankment showed no weakness. Revetment is in good condition and tile drains performed well.

Pecan Grove levee (973 L).—Two sloughs occurred on land slope. Loose earth was placed on river slope to a height of about 1 foot above level of water, with satisfactory result. These sloughs were caused by seepage water, tile drains having been omitted, owing to lack of funds.

There was a large leak, caused by crayfish or muskrat, between station 6 and station 7, through which there was a considerable flow of water during entire time that water remained against embankment, notwithstanding efforts of local authorities to stop it, and as it was not serious no work was done by the United States.

Story upper levee (974 L).—One crayfish leak developed at toe of land slope, 150 feet above Story crevasse of 1892.

Loose earth was placed in a mud box on river side, by direction of local authorities, but it had little effect. Some seepage at toe of land slope, owing to absence of tile drains, which were omitted owing to lack of funds.

Story lower levee (975 L).—Slight wave wash between station 1 and station 10. Line of tile drains under lower end of this levee discharged during entire flood, but as no washing around tiles was discovered work to check flow of water was considered unnecessary.

Repose levee (976 L).—Excepting wave wash between stations 0 plus 50 to 2, and 4 to 9, embankment showed no weakness. Wave wash was arrested by placing sacks filled with earth on river slope.

Orange Grove upper (980 L) and lower (980 L) levees showed slight seepage owing to absence of tile drains.

English Turn levee (981.5 L), 1893–'94, showed no defects.

CREVASSES.

St. Clair (982 L).—Break occurred June 14 at about noon, and was closed June 15 at 11 a. m. Width 10 feet; average depth of water through break was 6.5 feet. This crevasse was caused by crayfish leak.

Harlem crevasse (1003.2 L).—Occurred June 18 at about 4 p. m., and was closed June 30 at 2 p. m. Cause of break was the blowing or washing out of a wooden rice flume. Width of break, 187 feet; average depth of water 4.3 feet.

Pierre Cossé crevasse (1013 L).—Occurred June 20, at 9 a. m., and was closed at 5 p. m. the same day. Break resulted from leak made by "fiddlers." These little animals are very numerous in this locality. Width of break was 12 feet, and average depth of water 8.3 feet.

High-water protection by State and local authorities.—Levee in front of Story residence (973.5 L) raised about eight-tenths of a foot on river edge of crown for a dis-

tance of 1,900 feet. Levee just below United States Story lower levee (975 L) raised about 1 foot for a distance of 100 feet. Numerous crayfish leaks in old levee between Story lower levee and Lake Borgne Canal were worked on. Levee from Lake Borgne Canal down to a point about 2,500 feet below had many leaks, most of which were worked on.

For a distance of about 2,000 feet above to a point about 1,500 feet below the dividing line of St. Bernard and Plaquemine parishes the levee leaked badly. Some work was done by local levee board. From a point about 1,500 feet above, down to the upper end of the United States Orange Grove upper levee, the old levee was raised about eight-tenths of a foot with sacks filled with earth. Some crayfish leaks in about 2,000 linear feet of old levee on Caernarvon plantation were worked on. Old levee between United States Orange Grove upper and lower levees (979.5 L) was raised about 1 foot for a distance of about 1,000 feet. Some leaks in the old levee on St. Clair plantation (982 L) were worked on, and levee for a distance of about 100 feet was raised about 1 foot. The crevasse which occurred in this line of levee, as previously stated, was closed. Levee on Mon Plaisir and Scarsdale plantations showed some leaks, and work was done. Batture levee on Stella plantation was washed away, and the old levee about 200 feet back was raised about 1 foot for a distance of about 2,000 feet.

Harlem crevasse (1003.2 L) and Pierre Cossé crevasse (1013 L) were closed.

BARATARIA DISTRICT.

UNITED STATES LEVEES.

Magnolia levee (980.5 R).—One large leak, caused by crayfish or muskrat in lower section, was stopped by building cofferdam of sacks filled with earth on land side. Revetment in good condition and tile drains performed well.

Fort St. Leon upper levee (981.5 R).—Showed no defects. The old levee in front of Fort St. Leon residence was raised about eight-tenths of a foot for a distance of 1,200 feet.

Fort St. Leon lower levee (982.5 R).—Showed no weakness.

Belle Chasse crevasse levee (983 R).—One crayfish leak leveloped, and was stopped by placing loose earth in "mud box" on river side. Tile drains performed well.

Belle Chasse to Concession levee (985 R).—Slight wave wash on upper section was arrested by placing sacks of earth on river slope. Tile drains performed well and revetment is in good condition.

Concord levee (987 R) and Oak Point levee (988.5 R).—Showed no defects.

Live Oak levee (990.5 R).—Slight wave wash on upper section.

Happy Point levee (991.5 R).—Wave wash from station 8 to station 14 was arrested by placing sacks of earth on river slope. Tile drains performed well.

CREVASSES.

Magnolia crevasse (979 R) occurred June 15 at 9 a. m., and was closed June 25 at 6 p. m.; break was caused by a crayfish leak; it was 18 feet wide with an average depth of water 5.0 feet.

Bartholemy crevasse (1014.5 R) occurred June 14 at noon and was closed June 15 at about 6 p. m. This break was caused by the washing out of an old rice flume. It was 15 feet wide, and average depth of water through break was 6 feet.

High-water protection by State and local authorities.—Magnolia crevasse (979 R), previously mentioned, was closed by local authorities and citizens in neighborhood. Old levee between U. S. Fort St. Leon upper and lower levees was raised about eight-tenths foot for a distance of about 1,000 feet.

Levee between Belle Chasse crevasse and Belle Chasse to Concession United States levees had many leaks worked on.

Numerous leaks in old levee on Sarah plantation (990.7 R) were stopped. Old levee just below Star plantation (995.5 R) was badly wave washed and had many leaks. Temporary repairs were made. Some leaks in levee along front of Myrtle Grove plantation (1001 R) were stopped. Numerous leaks in old levee on Oakland plantation (1003.2 R) just above Junior, La., were worked on. Some crayfish leaks in old levee on Deer Range plantation (1004 R) were worked on; crevasse at Bartholemy settlement (1014.5 R) was closed.

Remarks.—The flume which caused the Harlem crevasse was left open for some time before the break occurred and the washing of earth under the box was not detected by local inspector. Had flume been closed, any serious weakness could have been discovered and break avoided. The other crevasses in these districts were of no importance. They were in small levees which had wide battures grown with willows, where little trouble was expected or feared.

Very respectfully, your obedient servant,

J. SMYTH, JR.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

Money statements.

LOWER TENSAS LEVEE DISTRICT.

me 1, 1893, balance unexpended		$16,675.43
mount allotted from act approved March 3, 1893		132,000.00
Total available		148,675.43
ay 31, 1894, amount expended during fiscal year:		
Construction and repairs of levees	$124,774.69	
Protection of levees	2,556.56	
Treasury settlement	123.30	
		127,454.55
[ay 31, 1894, balance unexpended		21,220.88
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		132,000.00

ATCHAFALAYA LEVEE DISTRICT.

une 1, 1893, balance unexpended		$27,116.33
mount allotted from act approved March 3, 1893		152,000.00
Total available		179,116.33
lay 31, 1894, amount expended during fiscal year:		
Construction and repairs of levees	$160,830.24	
Protection of levees	4,109.48	
		164,489.72
May 31, 1894, balance unexpended		14,626.61
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		152,000.00

LAFOURCHE LEVEE DISTRICT.

June 1, 1893, balance unexpended		$14,893.36
Amount allotted from act approved March 3, 1893		90,000.00
Total		104,893.36
May 31, 1894, amount expended during fiscal year:		
Construction and repair of levees	$89,217.36	
Protection of levees	3,965.70	
Treasury settlement	137.70	
		93,320.76
May 31, 1894, balance unexpended		11,572.60
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		90,000.00

PONTCHARTRAIN LEVEE DISTRICT.

June 1, 1893, balance unexpended		$17,828.57
Amount allotted from act approved March 3, 1893		150,000.00
Total available		167,828.57
May 31, 1894, amount expended during fiscal year:		
Construction and repair of levees	$159,063.79	
Protection of levees	6,321.65	
Treasury settlement	161.10	
		165,546.54
May 31, 1894, balance unexpended		2,282.03
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		150,000.00

LAKE BORGNE LEVEE DISTRICT.

June 1, 1893, balance unexpended		$295.19
Amount allotted from act approved March 3, 1893		50,000.00
Amount disallowed		21.14
Total available		50,316.33
May 31, 1894, amount expended during fiscal year:		
Construction and repair of levees	$42,116.73	
Protection of levees	265.57	
Treasury settlement	175.05	
		42,557.35
May 31, 1894, balance unexpended		7,758.98
May 31, 1894, amount covered by incomplete contracts		3,066.45
May 31, 1894, balance available		4,692.53
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		50,000.00

BARATARIA LEVEE DISTRICT.

June 1, 1893, balance unexpended		$2,433.84
Amount allotted from act approved March 3, 1893		60,000.00
Total available		62,433.84
May 31, 1894, amount expended during fiscal year:		
Construction and repair of levees	$46,981.86	
Protection of levees	3,012.40	
Treasury settlement	84.60	
		50,078.86
May 31, 1894, balance unexpended		12,354.98
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		60,000.00

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 4, 1893.

No. 11.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Davis Island (622 R)	
		Embankment 30,000 cubic yards.	Total cost of levee.
		Cents.	
1	Arnold, De Garis & Co., Memphis, Tenn	17	$5,100.00
7	Manning & Gibson, Natchez, Miss	13.94	4,182.00
9	Rutherford & Dalgarn, Natchez, Miss	14½	4,350.00
14	John Scott & Sons, St. Louis, Mo	30	9,000.00
15	J. S. McTighe & Co., Memphis, Tenn	13.43	4,035.00
16	Jeffries & Dameron, English Turn, La	19¾	5,925.00
17	McLaughlin Bros., Memphis, Tenn	22	6,600.00

No. 11.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River*—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Lake Concordia, new and enlargement (695 R).		
		Embankment, 38,000 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Arnold, De Garis & Co., Memphis, Tenn	15	16	$5,732.00
2	Donovan & Daley, Baton Rouge, La	14.45	15	5,521.00
3	Alexander Eltringham, Natchez, Miss	14	13	5,346.00
5	Hartnett & O'Brien, Memphis, Tenn	13	13	4,966.00
6	Albert H. Gillespie, Vidalia, La	*10.7	*10.7	4,087.40
7	Manning & Gibson, Natchez, Miss	12.89	12.89	4,923.98
8	James M. Sullivan, Memphis, Tenn	13.74	13.74	5,248.68
9	Rutherford & Dalgarn, Natchez, Miss	12.4	12.4	4,736 80
10	P. F. Lamb, Stafford, Miss	14½	14½	5,393.25
11	George C. Harvey, Vidalia, La	12½	10	4,770.00
12	John A. Carson, Baton, Rouge, La	18	16	6,872.00
14	John Scott & Sons, St. Louis, Mo	24	14	9,148.00
15	J. S. McTighe & Co., Memphis, Tenn	13½	13½	5,157.00
16	Jeffries & Dameron, English Turn, La	18	18	6,876.00
17	McLaughlin Bros., Memphis, Tenn	12.43	12.43	4,748.26
18	Charles T. Worthington, Leota, Miss	13.74	13	5,247.20

No.	Name and address of bidder.	Cottage Home (649 R).		
		Embankment, 50,000 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Arnold, De Garis & Co., Memphis, Tenn	15⅛	16	$7,844.50
2	Donovan & Daley, Baton Rouge, La	14.95	15	7,505.00
4	Edwin B. Helgason, Natchez, Miss	*12½	*12.45	6,399.90
5	Hartnett & O'Brien, Memphis, Tenn	14½	14½	7,404.50
7	Manning & Gibson, Natchez, Miss	12½	12½	6,400.50
8	James M. Sullivan, Memphis, Tenn	18½	18½	9,412.50
9	Rutherford & Dalgarn, Natchez, Miss	16½	16½	8,283.00
10	P. F. Lamb, Stafford, Miss	15⅜	15⅜	7,718.25
14	John Scott & Sons, St. Louis, Mo	16½	14	8,278.00
15	J. S. McTighe & Co., Memphis, Tenn	13.20	13.20	6,626.40
16	Jeffries & Dameron, English Turn, La	18	18	9,036.00
17	McLaughlin Bros., Memphis, Tenn	14.73	12	7,389.00
18	Charles T. Worthington, Leota, Miss	14.49	14	7,273.00

No.	Name and address of bidder.	Morville to Groens, enlargement (715 R).		
		Embankment, 45,000 cubic yards.	Base ditches, etc., 2,000 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Arnold, De Garis & Co., Memphis, Tenn	29½	28	$13,947.50
3	Alexander Eltringham, Natchez, Miss	29	18	13,413.00
8	James M. Sullivan, Memphis, Tenn	22	22	10,340.00
9	Rutherford & Dalgarn, Natchez, Miss	27	27	12,690.00
12	John A. Carson, Baton Rouge, La	17	16	7,970.00
13	Samuel L. James, jr., Baton Rouge, La	*16	*13	7,460.00
14	John Scott & Sons, St. Louis, Mo	25	14	11,530.00
15	J. S. McTighe & Co., Memphis, Tenn	30	30	14,100.00
16	Jeffries & Dameron, English Turn, La	25	25	11,750.00
17	McLaughlin Bros., Memphis, Tenn	20	18	9,360.00
18	Charles T. Worthington, Leota, Miss	23	20	10,750.00

REMARKS.—Proposals marked thus *, being the lowest, and the bidders considered responsible, are recommended for acceptance. Both copies of bid No. 4 are submitted (copy retained in office), as bidder submitted separate bids on each levee, but not in duplicate.

No. 11.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River*—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Hardscrabble enlargement (643 R).		Bondurant enlargement (644 R).	
		Embankment, 30,000 cubic yards.	Total cost of levee.	Embankment, 16,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Arnold, De Garis & Co., Memphis, Tenn	24½	$7,425.00	23½	$3,800.00
4	Edwin B. Helgason, Natchez, Miss	.....	.....	* 14.43	2,308.80
8	James M. Sullivan, Memphis, Tenn	37	11,100.00	21	3,360.00
9	Rutherford & Dalgarn, Natchez, Miss	.....	.....	21	3,360.00
14	John Scott & Sons, St. Louis, Mo	24	7,200.00	24	3,840.00
15	J. S. McTighe & Co., Memphis, Tenn	40	7,200.00	14.94	2,390.40
16	Jeffries & Dameron, English Turn, La	32	9,600.00	17	2,720.00
17	McLaughlin Bros., Memphis, Tenn	25	7,500.00	21	3,360.00
18	Charles T. Worthington, Leota, Miss	* 19	5,700.00	20	3,200.00

REMARKS.—Proposals marked thus * being the lowest, and the bidders considered responsible, are recommended for acceptance. Both copies of bid No. 4 are submitted (copy retained in office). Each bidder submitted separate bids on each levee, but not in duplicate.

Amount available	$108,000
Amount covered by this abstract	30,000
Balance	78,000

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 5, 1893.

No. 12.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

ATCHAFALAYA LEVEE DISTRICT.

No.	Name and address of bidder.	Fleta (786 R).		Provosty (796 R).	
		Embankment, 105,000 cubic yards.	Total cost of levee.	Embankment, 80,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Israel R. Bobbitt, Baton Rouge, La	.....	.....	15.96	$12,768.00
2	T. W. Scott, St. Louis, Mo	.....	.....	17	13,600.00
3	Arnold, De Garis & Co., Memphis, Tenn	23½	$25,068.00	21½	17,300.00
4	Andrews Bros. Construction Co., Baton Rouge, La.	17.44	18,312.20	16.24	12,992.00
5	James Cotton, Raccourci, La	32	33,600.00	26	20,800.00
6	Charles T. Worthington, Leota, Miss	16	16,800.00	15½	12,400.00
7	J. S. McTighe & Co., Memphis, Tenn	17.42	18,291.00	15.93	12,744.00
8	McLaughlin Bros., Memphis, Tenn	31	32,550.00	19½	15,600.00
11	Hayes Bros., Baton Rouge, La	24	25,200.00	14.80	11,840.00
12	R. M. Quigley & Co., St. Louis, Mo	* 15.74	16,527.00	16.94	13,552.00
13	James M. Sullivan, Memphis, Tenn	27	28,350.00	16	12,800.00
14	Hartnett & O'Brien, Memphis, Tenn	20	21,000.00	* 14	11,200.00
15	Barbour & Ruple, Laplace, La	26	27,300.00	22½	18,000.00
18	John Scott & Sons, St. Louis, Mo	21.43	22,501.50	17.73	14,184.00
21	Jeffries & Dameron, English Turn, La	24	25,200.00	21	16,800.00
24	Homan & McFadden, Sarpy, La	24.4	25,620.00	27	21,600.00
26	Donovan & Daley, Baton Rouge, La	20.42	21,472.50	16.45	13,160.00
29	S. D. Moody & Co., Limited, New Orleans, La	39	40,950.00	34	27,200.00
30	Cannon & Atkins, Greenville, Miss	18½	19,818.75	16½	13,200.00
32	Starling, Smith & Co., Greenville, Miss	15.97	16,768.50	17.97	14,376.00
27	Manning & Gibson, Natchez, Miss	.....	.....	16½	13,200.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders responsible, are recommended for acceptance.

No. 12.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River*—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Golden Ridge (861.5 R).		Harroll (866 R).	
		Embankment, 41,500 cubic yards.	Total cost of levee.	Embankment, 49,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Israel R. Bobbitt, Baton Rouge, La	14.70	$6,100.50	14.96	$7,330.40
2	T. W. Scott, St. Louis, Mo	19	7,885.00	19	9,310.00
3	Arnold, De Garis & Co., Memphis, Tenn	18⅞	7,833.12	18⅝	9,126.25
4	Andrew Bros. Construction Co., Baton Rouge, La	16	6,640.00	14.74	7,222.60
5	James Cotten, Raccourci, La	20	8,300.00	22	10,780.00
6	Charles T. Worthington, Leota, Miss	14½	6,017.50	14½	7,105.00
7	J. S. McTighe & Co., Memphis, Tenn	13.24	5,494.60	*12.99	6,365.10
8	McLaughlin Bros., Memphis, Tenn	14.99	6,220.85	15	7,350.00
9	Michael Hanick, St. Louis, Mo	*12	4,980.00	13½	6,615.00
10	S. L. James, jr., Baton Rouge, La	15	6,225.00	16.99	8,325.10
11	Hayes Bros., Baton Rouge, La	13.45	5,581.75	13.75	6,737.50
12	R. M. Quigley & Co., St. Louis, Mo	13.84	5,743.60	13.84	6,781.60
13	James M. Sullivan, Memphis, Tenn	15½	6,432.50	15¾	7,717.50
14	Hartnett & O'Brien, Memphis, Tenn	13.99	5,805.85	13.99	6,855.10
15	Barbour & Ruple, Laplace, La	16.95	7,034.25	15½	7,472.50
16	John G. Sessions, Hampton, Miss	16½	6,743.75	16.49	8,080.10
17	C. D. Leeper & Co., Baton Rouge, La	19	7,885.00	16.90	8,281.00
18	John Scott & Sons, St. Louis, Mo	13.73	5,697.95	13.73	6,727.70
19	G. Ed. Mott, New Orleans, La	16	6,640.00	15.49	7,590.00
20	W. H. O'Connell, New Texas, La	14.94	6,200.10	.....	.....
21	Jeffries & Dameron, English Turn, La	16	6,640.00	15¾	7,717.50
22	Mike Kane, Baton Rouge, La	13½	5,498.75	16	7,840.00
23	Hearin & Cunningham, Baton Rouge, La	17½	7,366.25	15.9	7,791.00
24	Homan & McFadden, Sarpy, La	17½	7,262.50	16½	8,085.00
25	James B. Portman, Lewisville, Tex	13.95	5,789.25	13.90	6,811.00
26	Donovan & Daley, Baton Rouge, La	13.95	5,789.25	13.97	6,845.30
27	Manning & Gibson, Natchez, Miss	.....	.....	16½	8,085.00
28	Leche & Byrnes, Island P. O., La	15½	6,432.50	13.98	6,850.20
29	S. D. Moody & Co., Limited, New Orleans, La	17.89	7,424.35	17.89	8,766.00
30	Cannon & Atkins, Greenville, Miss	14⅜	5,965.75	14⅜	7,043.75
31	Robt. K. Colquitt, Shreveport, La	16.74	6,947.10	17.74	8,692.60
32	Starling, Smith & Co., Greenville, Miss	18	7,470.00	14½	7,105.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders responsible, are recommended for acceptance.

Amount available	$60,000
Amount covered by this abstract	40,000
Balance	20,000

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 6, 1892.

No. 13.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, Mississippi River.*

LAFOURCHE LEVEE DISTRICT.

No.	Name and address of bidd	Brookstown (897 R).		Waterford (922 R).	
		Embankment, 55,000 cubic yards.	Total cost of levee.	Embankment, 53,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Andrews Bros. Construction Co., Baton Rouge, La.	14	$7,700.00	14.74	$7,8[illegible]
2	Donovan & Daley, Baton Rouge, La.	13.47	7,408.50	13.94	7,38[illegible]
3	J. S. McTighe & Co., Memphis, Tenn.	17½	9,625.00	17¾	9,40[illegible]
4	Jas. B. Portman, Lewisville, Tex.	15	8,250.00	14	7,42[illegible]
5	Barbour & Ruple, Laplace, La.	15.35	8,442.50	14.90	7,89[illegible]
6	C. D. Leeper & Co., Baton Rouge, La.	17.90	9,845.00	15½	8,21[illegible]
7	Hartnett & O'Brien, Memphis, Tenn.	17	9,350.00	16½	8,74[illegible]
8	Leche & Byrnes, Island P. O., La.	16½	8,937.50	15½	8,06[illegible]
9	John Scott & Sons, St. Louis, Mo.	14	7,700.00	14	7,42[illegible]
10	Hearin & Cunningham, Baton Rouge, La.	16.73	9,201.50	14.24	7,54[illegible]
11	Hayes Bros., Baton Rouge, La.	*13.45	7,397.50	*13	6,89[illegible]
12	Robert McNamara, New Orleans, La.			17½	9,27[illegible]
13	G. Ed. Mott, New Orleans, La.	20	11,000.00	16	8,48[illegible]
14	Cannon & Atkins, Greenville, Miss.	16½	9,212.50	15½	8,21[illegible]
15	Jeffries & Dameron, English Turn, La.	17	9,350.00	18	9,54[illegible]
18	Arnold, De Garis & Co., Memphis, Tenn.	15⅝	8,593.75	14⅝	7,73[illegible]
19	S. D. Moody & Co., Limited, New Orleans, La.	17.90	9,845.00	17½	9,10[illegible]
20	McLaughlin Bros., Memphis, Tenn.	16.49	9,069.50	15	7,95[illegible]
22	Israel R. Bobbitt, Baton Rouge, La.	15½	8,387.50	14½	7,68[illegible]
23	Charles T. Worthington, Leota, Miss.	18	9,900.00	18	9,54[illegible]
24	James M. Sullivan, Memphis, Tenn.	18½	10,037.50	18½	9,80[illegible]
25	Homan & McFadden, Sarpy, La.	18	9,900.00	15½	8,21[illegible]
26	John A. Carson, Baton Rouge, La.	17	9,350.00	16	8,48[illegible]
27	W. J. Bentley & Co., New Orleans, La.	15	8,250.00		

No.	Name and address of bidd	Coopersville (944 R).		Alice (945 R).	
		Embankment, 43,000 cubic yards.	Total cost of levee.	Embankment, 55,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Andrews Bros. Construction Co., Baton Rouge, La.	*12.92	$5,555.60	12	$6,60[illegible]
2	Donovan & Daley, Baton Rouge, La.	13¾	5,912.50	13.96	7,67[illegible]
3	J. S. McTighe & Co., Memphis, Tenn.	16½	7,095.00	16½	9,07[illegible]
4	James B. Portman, Lewisville, Tex.	14½	6,235.00	13.93	7,66[illegible]
5	Barbour & Ruple, Laplace, La.	14.3	6,149.00	15.7	8,63[illegible]
6	C. D. Leeper & Co., Baton Rouge, La.	30	12,900.00	21½	11,82[illegible]
7	Hartnett & O'Brien, Memphis, Tenn.	15½	6,665.00	15½	8,52[illegible]
8	Leche & Byrnes, Island P. O., La.	15	6,450.00	14	7,70[illegible]
9	John Scott & Sons, St. Louis, Mo.	14	6,020.00	14	7,70[illegible]
10	Hearin & Cunningham, Baton Rouge, La.	14.74	6,338.20	14.24	7,83[illegible]
11	Hayes Bros., Baton Rouge, La.	14¼	6,127.50	14.74	8,10[illegible]
12	Robert McNamara, New Orleans, La.	17	7,310.00	17	9,35[illegible]
13	G. Ed. Mott, New Orleans, La.	17	7,310.00	16½	9,07[illegible]
14	Cannon & Atkins, Greenville, Miss.	16⅞	7,256.25	16⅞	9,28[illegible]
15	Jeffries & Dameron, English Turn, La.	15	6,450.00	15	8,25[illegible]
16	Robert K. Colquitt, Shreveport, La.	16.98	7,301.40	14.87	8,17[illegible]
17	Codifer & Clancy, New Orleans, La.	18	7,740.00	16	8,80[illegible]
18	Arnold, De Garis & Co., Memphis, Tenn.	15½	6,503.75	14¼	8,04[illegible]
19	S. D. Moody & Co., Limited, New Orleans, La.	17	7,310.00	17½	9,63[illegible]
20	McLaughlin Bros., Memphis, Tenn.	15.49	6,660.70	15	8,25[illegible]
21	John E. Louque, Carrollton, La.	17½	7,525.00	16½	9,07[illegible]
22	Israel R. Bobbitt, Baton Rouge, La.	15⅞	6,611.25	15	8,25[illegible]
23	Chas. T. Worthington, Leota, Miss.	18	7,740.00	18	9,90[illegible]
24	Jas. M. Sullivan, Memphis, Tenn.	16.37	7,039.10	16.43	9,03[illegible]
25	Homan & McFadden, Sarpy, La.	14.7	6,321.11	13½	7,42[illegible]
26	J. A. Carson, Baton Rouge, La.	16	6,880.00	15	8,25[illegible]
27	W. J. Bentley & Co., New Orleans, La.	16	6,880.00	16	8,80[illegible]

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. The acceptance of bid No. 1 for Alice levee is not recommended on account of lack of funds.

Amount available.....[illegible]
Amount covered by this abstract.....[illegible]

Balance.....[illegible]

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 7, 1893.

No. 14.—*Abstract of proposals received in response to advertisement dated August 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, Mississippi River.*

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name and address of bidder.	Conrad (843 L).		Ben Hur (845 L).	
		Embankment, 28,000 cubic yards.	Total cost of levee.	Embankment, 73,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	John G. Sessions, Hampton, Miss	13.98	$3,914.40	15.74	$11,490.00
2	Hearin & Cunningham, Baton Rouge, La	12	3,360.00	14	10,220.00
3	James M. Sullivan, Memphis, Tenn	13½	3,710.00	12.93	9,438.90
4	S. D. Moody & Co., Limited, New Orleans, La	15.95	4,466.00	15.72	11,475.60
6	C. D. Leeper & Co., Baton Rouge, La	14.7	4,116.00	15.3	11,169.00
7	Leche & Byrnes, Island, La	15⅝	4,410.00	18	13,140.00
8	Robt. K. Colquitt, Shreveport, La	14.87	4,163.60	14.87	10,855.10
10	Andrews Bros. Construction Co., Baton Rouge, La	18	5,040.00	13½	9,855.00
11	Israel R. Bobbitt, Baton Rouge, La	15½	4,270.00	14⅞	10,858.75
12	J. A. Carson, Baton Rouge, La	16	4,480.00	17	12,410.00
13	Robert McNamara, New Orleans, La	17	4,760.00	17½	12,775.00
14	J. S. McTighe & Co., Memphis, Tenn	17	4,760.00	16¾	12,227.75
15	G. Ed. Mott, New Orleans, La	15⅛	4,340.00	16.95	12,373.50
16	Hayes Bros., Baton Rouge, La	16	4,480.00	16	11,680.00
17	G. B. Edwards, Bessemer, Ala	17.9	5,012.00	.....	.....
18	Thos. O'Malley, Baton Rouge, La	14	3,920.00	14	10,220.00
19	Jeffries & Dameron, English Turn, La	14	3,920.00	15	10,950.00
20	John Scott & Sons, St. Louis, Mo	13	3,640.00	13	9,490.00
21	Barbour & Ruple, Laplace, La	15.30	4,284.00	14.73	10,752.00
22	Cannon & Atkins, Greenville, Miss	13⅜	3,745.00	14⅞	10,858.75
24	McLaughlin Bros., Memphis, Tenn	14¼	3,990.00	14	10,220.00
25	W. J. Bentley & Co., New Orleans, La	15⅛	4,340.00	16½	12,045.00
26	T. W. Scott, St. Louis, Mo	14	3,920.00	*11.40	8,322.00
27	W. H. O'Connell, New Texas, La	13.85	3,878.00	16.95	12,373.50
28	Michael Hanick, St. Louis, Mo	13½	3,780.00	11¾	8,577.50
29	Mike Kane, Baton Rouge, La	*11.99	3,357.20	14	10,220.00
30	Starling & Smith Co., Greenville, Miss	.....	.....	17⅜	12,683.75
31	Donovan & Daley, Baton Rouge, La	13½	3,710.00	12.74	9,300.00
33	Hartnett & O'Brien, Memphis, Tenn	15	4,200.00	14½	10,585.00
34	Homan & McFadden, Sarpy, La	12	3,360.00	13.4	9,782.00
35	Arnold, De Garis & Co., Memphis, Tenn	14	3,920.00	14⅜	10,676.25
36	Eltringham Construction Co., Natchez, Miss	16½	4,620.00	16	11,680.00
38	Jas. B. Portman, Lewisville, Tex	.....	.....	13.3	9,709.00

No.	Name and address of bidder.	Plaquemine Point, enlargement (853 L).		Hard Times (873 L).	
		Embankment, 40,000 cubic yards.	Total cost of levee.	Embankment, 35,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	John G. Sessions, Hampton, Miss	13.93	$5,592.00	.....	.....
2	Hearin & Cunningham, Baton Rouge, La	15½	6,200.00	14.47	$5,064.50
3	Jas. H. Sullivan, Memphis, Tenn	12.74	5,096.00	13.97	4,889.00
4	S. D. Moody & Co., Limited, New Orleans, La	14½	5,800.00	17½	6,125.00
6	C. D. Leeper & Co., Baton Rouge, La	14.1	5,640.00	.....	.....
8	Robt. K. Colquitt, Shreveport, La	.....	.....	15.87	5,554.50
10	Andrews Bros. Construction Co., Baton Rouge, La	15	6,000.00	13.24	4,634.00
11	Israel R. Bobbitt, Baton Rouge, La	12⅞	5,150.00	14½	5,075.00
12	John A. Carson, Baton Rouge, La	13	5,200.00	15	5,250.00
13	Robert McNamara, New Orleans, La	14½	5,800.00	.....	.....
14	J. S. McTighe & Co., Memphis, Tenn	13¾	5,400.00	16	5,600.00
15	G. Ed. Mott, New Orleans, La	14.40	5,760.00	20	7,000.00
16	Hayes Bros., Baton Rouge, La	18	7,200.00	17	5,950.00
17	G. B. Edwards, Bessemer, Ala	11.44	4,576.00	11.94	4,179.00
18	Thos. O'Malley, Baton Rouge, La	14	5,600.00	14	4,900.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Proposals Nos. 17 and 30 on Hard Times levee are the same. The bidders having agreed among themselves, the bid of G. B. Edwards, No. 17, is recommended for acceptance.

No. 14.—*Abstract of proposals received in response to advertisement dated August 21, 1882, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, Mississippi River*—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Plaquemine Point, enlargement (853 L).		Hard Times (873 L).	
		Embankment, 40,000 cubic yards.	Total cost of levee.	Embankment, 35,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
19	Jeffries & Dameron, English Turn, La	14	$5,600.00	16	$5,600.00
20	John Scott & Sons, St. Louis, Mo	14	5,600.00	13	4,550.00
21	Barbour & Ruple, Laplace, La	14.7	5,880.00	15	5,250.00
22	Cannon & Atkins, Greenville, Miss	16⅜	6,550.00	15⅜	5,387.25
24	McLaughlin Bros., Memphis, Tenn	13⅜	5,500.00	25	8,750.00
25	W. J. Bentley & Co., New Orleans, La	13.9	5,560.00		
26	T. W. Scott, St. Louis, Mo	*11.40	4,160.00	14	4,900.00
28	Michael Hanick, St. Louis, Mo	13	5,200.00	12½	4,375.00
29	Mike Kane, Baton Rouge, La	15	6,000.00	11.94	4,179.00
30	Starling & Smith Co., Greenville, Miss			14	4,900.00
31	Donovan & Daley, Baton Rouge, La	16.94	6,776.00	13.94	4,879.00
33	Hartnett & O'Brien, Memphis, Tenn	14	5,600.00	15	5,250.00
34	Homan & McFadden, Sarpy, La	11.4	4,560.00	14	5,901.96
35	Arnold, De Garis & Co., Memphis, Tenn	13⅜	5,350.00	16⅜	5,818.75
36	Eltringham Construction Co., Natchez, Miss	18	7,200.00	14.45	5,057.50
37	S. L. James, jr., Baton Rouge, La	16.99	6,796.00		
38	Jas. B. Portman, Lewisville, Tex			13.43	4,700.50

No.	Name and address of bidder.	Rescue (875 L).		Trudeau (849 L).	
		Embankment, 50,000 cubic yards.	Total cost of levee.	Embankment, 34,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
2	Hearin & Cunningham, Baton Rouge, La	14.47	$7,235.00	23½	$7,990.00
3	Jas. M. Sullivan, Memphis, Tenn	15⅜	7,875.00		
5	Codifer & Clancy, New Orleans, La			22.9	7,786.00
8	Robt. K. Colquitt, Shreveport, La				
9	John Cleary, Carrollton, La			29	9,860.00
10	Andrews Bros. Construction Co., Baton Rouge, La	18	9,000.00	18	6,120.00
11	Israel R. Bobbitt, Baton Rouge, La	17½	8,750.00	18½	6,290.00
12	J. A. Carson, Baton Rouge, La	15	7,500.00	17	5,780.00
13	Robert McNamara, New Orleans, La			24	8,160.00
14	J. S. McTighe & Co., Memphis, Tenn	18	9,000.00	27	9,180.00
15	G. Ed. Mott, New Orleans, La	21.95	10,975.00		
16	Hayes Bros., Baton Rouge, La	18	9,000.00		
18	Thos. O'Malley, Baton Rouge, La	14⅜	7,375.00	*14	4,760.00
19	Jeffries & Dameron, English Turn, La	16⅜	8,250.00	20	6,800.00
20	John Scott & Sons, St. Louis, Mo	16⅜	8,250.00	25	8,500.00
21	Barbour & Ruple, Laplace, La	15.65	7,825.00	21.70	7,378.00
22	Cannon & Atkins, Greenville, Miss	20	10,000.00	20	6,800.00
23	John E. Louque, Carrollton, La			24½	8,330.00
24	McLaughlin Bros., Memphis, Tenn	17	8,500.00	17	5,780.00
25	W. J. Bentley & Co., New Orleans, La	15½	7,750.00		
26	T. W. Scott, St. Louis, Mo	15½	7,750.00		
28	Michael Hanick, St. Louis, Mo	*13⅛			
29	Mike Kane, Baton Rouge, La	15	7,500.00		
30	Starling & Smith Co., Greenville, Miss	16.74	8,370.00		
31	Donovan & Daley, Baton Rouge, La	14.44	7,220.00		
32	S. L. Davis, Belle Helene, La	16.94	8,470.00		
33	Hartnett & O'Brien, Memphis, Tenn	14.99	7,495.00		
34	Homan & McFadden, Sarpy, La	17.3	8,650.00	18	6,120.00
35	Arnold, De Garis & Co., Memphis, Tenn	18⅜	9,187.50	19⅝	6,672.50
36	Eltringham Construction Co., Natchez, Miss	16.45	8,225.00		
38	Jas. B. Portman, Lewisville, Tex	17	8,500.00		

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Proposals Nos. 17 and 30 on Hard Times levee are the same. The bidders having agreed among themselves, the bid of G. B. Edwards, No. 17, is recommended for acceptance.

Amount available	$40,000
Amount covered by this abstract	22,000
Balance	17,000

3 (1895).—*Abstract of proposals received in response to advertisement dated February 16, 94, opened this day by Capt. John Millis, Corps of Engineers, for the construction of ees in the fourth district, improving Mississippi River*—Continued.

Name and address of bidder.	Atchafalaya levee district—Anchorage.		
	Embankment, 52,700 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.
	Cents.	*Cents.*	
James M. Sullivan, Memphis, Tenn	14⅜	14⅜	$7,847.00
Hayes Bros., Bonnet Carre, La	* 10	* 10	5,320.00
John Scott & Sons, St. Louis, Mo	12.74	10	6,763.98
Heman & McFadden, Baton Rouge, La	13	10	6,901.00
W. J. Bentley & Co., New Orleans, La	12⅜	12⅜	6,783.00
The Eltringham Construction Co., Natches, Miss	10.73	10	5,704.71
N. P. Phillips, Red Liver Landing, La	16	16	8,512.00
Donovan, Daley & Co., Baton Rouge, La	11.70	8	6,205.90
D. B. Hearin & Co., Baton Rouge, La	10.73	10	5,704.71
Michael Hanick & Co., Baton Rouge, La	13	12	6,911.00
Manning & Gibson, Natchez, Miss	12.70	12.70	6,756.40
Hartnett & O'Brien, Point Coupee, La	12.74	12.74	6,777.68
Edwin B. Helgason, Natchez, Miss	10¼	10¼	5,453.00

MARKS.—Proposals marked thus *, are the lowest received and the bidders considered responsible, ecommended for acceptance.

unt available	$136,750.30
unt covered by this abstract	16,552.95
Balance	120,197.35

SURVEYS, GAUGES, AND OBSERVATIONS.

he usual discharge measurements were made during the high water of 1893 at rollton, at Red River Landing, and at Simmesport on the Atchafalaya. Surveys letermine changes in the river bottom in the vicinity of Belmont and Sarpy asses and above College Point were completed and results submitted. Special eys have also been made, in compliance with instructions of the Commission of ust 5, 1893, in the vicinity of Kennerville and near the old Lake Borgne Canal. here were no difficulties of navigation in the main river channel in this district ing the low-water season, and no channel depths less than 10 feet were reported.

Money statement.

e 1, 1893, balance unexpended	$6,553.09
tment approved by Secretary of War, May 18, 1893	12,000.00
Total available	18,553.09
31, 1894, amount expended during fiscal year	7,722.29
e 1, 1894, balance available	10,830.80
mount that can be profitably expended in fiscal year ending June 30, 1896 ibmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	12,000.00

No. 15.—*Abstract of proposals received in response to advertisement dated September 20, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River*—Continued

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Anchorage (831.5 R.). Embankment, 53,000 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee
		Cents.	*Cents.*	
19	Donovan, Daley & Co., Dreyfus, La	13.70	12	$7,12[illegible]
21	Hartnett & O'Brien, Memphis, Tenn	16.24	15	8,6[illegible]
22	J. A. Carson, Baton Rouge, La	18		
23	Davis & Freeman, Birmingham, Ala	14½	14	7,8[illegible]
24	George Mercier, New Orleans, La	15½	9	8,39[illegible]
25	Israel R. Bobbitt, Egg Bend, La	15.96	12	8,51[illegible]
26	Robert McNamara, New Orleans, La	18	15	9,65[illegible]
27	Chas. T. Worthington, Leota, Miss	15½	15½	8,2[illegible]

No.	Name and address of bidder.	Homestead (832 R.). Embankment, 11,000 cubic yards.	Base ditches, etc., 150 cubic yards.	Total cost of levee
		Cents.	*Cents.*	
5	Quinn & Phillips, Red River Landing, La	14	14	$1,561.[illegible]
6	James B. Portman & Co., Baton Rouge, La	14		
7	Straing & Lee, Kansas City, Mo	13¾		
8	The Eltringham Construction Co., Natchez, Miss	14.72	14½	1,64[illegible]
9	R. M. Quigley & Co., St. Louis, Mo	12	12	1,3[illegible]
10	C. D. Leeper & Co., Baton Rouge, La	15	15	1,6[illegible]
11	Wm. H. O'Connell, New Texas, La	14½	14½	1,6[illegible]
12	John Scott & Sons, St. Louis, Mo	12.93	10	1,47[illegible]
13	Kane & Hanick, Baton Rouge, La	14	10	1,5[illegible]
14	Sam D. Ross, Birmingham, Ala	14.93	14.93	1,66[illegible]
15	Homan & McFadden, Sarpy, La	14	14	1,56[illegible]
16	Andrews Bros. Construction Co., Baton Rouge, La	15½	12	1,72[illegible]
17	Jeffries & Dameron, English Turn, La	16	16	1,7[illegible]
18	S. D. Moody & Co., Limited, New Orleans, La	15½		
19	Donovan, Daley & Co., Dreyfus, La	13.70	12	1,52[illegible]
20	D. B. Hearin & Co., Baton Rouge, La	13	13	1,44[illegible]
22	J. A. Carson, Baton Rouge, La	18		
23	Davis & Freeman, Birmingham, Ala	16½	16	1,66[illegible]
25	Israel R. Bobbitt, Egg Bend, La	14	12	1,55[illegible]
26	Robert McNamara, New Orleans, La	18	15	2,0[illegible]
28	John Appel, Burnside, La	*14½	*14½	1,61[illegible]

No.	Name and address of bidder.	Port Allen (832.5 R.). Embankment, 92,000 cubic yards.	Base ditches, etc., 760 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
2	H. S. Flynn & Bro., Baton Rouge, La	14.90	12½	$13,80[illegible]
5	Quinn & Phillips, Red River Landing, La	17	17	15,70[illegible]
6	James B. Portman & Co., Baton Rouge, La	15		
7	Straing & Lee, Kansas City, Mo	15		
8	The Eltringham Construction Co., Natchez, Miss	14.23	14.93	13,26[illegible]
9	R. M. Quigley & Co., St. Louis, Mo	14½	14½	13,45[illegible]
12	John Scott & Sons, St. Louis, Mo	12.93	10	11,97[illegible]
13	Kane & Hanick, Baton Rouge, La	16	15	14,83[illegible]
14	Sam D. Ross, Birmingham, Ala	15.43	15.43	14,31[illegible]
15	Homan & McFadden, Sarpy, La	15.4	15.4	14,26[illegible]
16	Andrews Bros. Construction Co., Baton Rouge, La	15	12	13,98[illegible]
17	Jeffries & Dameron, English Turn, La	18	18	16,60[illegible]
18	S. D. Moody & Co., Limited, New Orleans, La	16½		
19	Donovan, Daley & Co. Dreyfus, La	14.70	12	13,61[illegible]
22	J. A. Carson, Baton Rouge, La	17		
23	Davis & Freeman, Birmingham, Ala	16½	16½	15,30[illegible]
26	Robert McNamara, New Orleans, La	20	15	18,51[illegible]
27	Chas. T. Worthington, Leota, Miss	16	16	14,84[illegible]

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. No recommendation for acceptance of lowest bids on Poplar Grove, Anchorage, and St. Louis levees is made at present. Some or all of these are to be omitted to enable more urgent work to be done, as authorized by telegram from Chief of Engineers of October 11, 1893. One copy of proposals of Davis & Freeman (23) on Anchorage levee for embankment is 14.75, the other copy 14.90.

. 15.—*Abstract of proposals received in response to advertisement dated September 20, '893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of ervees in the fourth district, improving Mississippi River*—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

	Name and address of bidder.	Nereaux (851 R).		
		Embankment, 85,000 cubic yards.	Base ditches, etc., 450 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
	James Cotton, Raccourci, La	22½	10	$19,170.00
	Straing & Lee, Kansas City, Mo	14¾		
	R. M. Quigley & Co., St. Louis, Mo	14.94	14.94	12,706.23
	John Scott & Sons, St. Louis, Mo	*12.93	*10	11,035.50
	Kane & Hanick, Baton Rouge, La	13.49	12	11,520.50
	Sam D. Ross, Birmingham, Ala	14.39	14.39	22,296.25
	Homan & McFadden, Sarpy, La	14.7	14.7	12,561.15
	Andrews Bros. Construction Co., Baton Rouge, La	13.9	12	11,869.00
	Jeffries & Dameron, English Turn, La	19	19	16,235.50
	S. D. Moody & Co., Limited, New Orleans, La	15½		
	Donovan, Daley & Co., Dreyfus, La	17.40	12	14,844.00
	J. A. Carson, Baton Rouge, La	18		
	Davis & Freeman, Birmingham, Ala	16½	16½	14,099.25
	Israel R. Bobbitt, Egg Bend, La	16	12	13,645.00
	Robert McNamara, New Orleans, La	18	15	15,367.50
	Chas. T. Worthington, Leota, Miss	17	17	14,526.50

o.	Name and address of bidder.	St. Louis (856 R).		
		Embankment, 24,000 cubic yards.	Base ditches, etc., 400 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Michael Walsh, Plaquemine, La	14.97	14.97	$3,652.68
3	James Cotton, Raccourci, La	22½	10	5,440.00
7	Straing & Lee, Kansas City, Mo	14¾		
9	R. M. Quigley & Co., St. Louis, Mo	15¼	15¼	3,843.00
12	John Scott & Sons, St. Louis, Mo	12.93	10	3,143.20
13	Kane & Hanick, Baton Rouge, La	12.99	12	3,165.60
14	Sam D. Ross, Birmingham, Ala	16.64	16.64	4,060.16
15	Homan & McFadden, Sarpy, La	15.02	15 02	3,708.80
16	Andrews Bros. Construction Co., Baton Rouge, La	15¾	15¾	3,843.00
17	Jeffries & Dameron, English Turn, La	19	19	4,636.00
22	J. A. Carson, Baton Rouge, La	16		
23	Davis & Freeman, Birmingham, Ala	15.98	14½	3,891.70
25	Israel R. Bobbitt, Egg Bend, La	14½	12	3,528.00
26	Robert McNamara, New Orleans, La	17	15	4,140.00
27	Chas. T. Worthington, Leota, Miss			
28	John Appel, Burnside, La	15½	15½	3,782.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. No recommendation for acceptance of lowest bids on Poplar Grove, Anchorage, and St. Louis levees is made at present. Some or all of these are to be omitted to enable more urgent work to be done, as authorized by telegram from Chief of Engineers of October 11, 1893. One copy of proposals of Davis & Freeman (23) on Anchorage levee for embankment is 14.75, the other copy 14.90.

Amount available	$56,887.15
Amount covered by this abstract	26,082.22
Balance	30,804.93

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 10, 1893.

No. 16.—*Abstract of proposals received in response to advertisement dated September 30, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Videl, enlargement (615 R).		Hard Times—Willow enlargement (632 R.	
		Embankment and excavations, 40,000 cubic yards.	Total cost of levee.	Embankment and excavations, 50,000 cubic yards.	Total cost of levee
		Cents.		*Cents.*	
1	R. T. Martin & Co., Baton Rouge, La			*18.73	$9,365.00
2	Leeper & Bobbitt, Donaldsonville, La	21	$8,400.00	18½	9,375.00
3	L. M. Dalgarn, Natchez, Miss	17	6,800.00	18½	9,375.00
4	Jeffries & Dameron, English Turn, La			24	12,000.00
5	Garbish & O'Neil, Memphis, Tenn	*13⅜	5,350.00		
6	Chas. T. Worthington, Leota, Miss			25¼	12,750.00
7	Davis & Freeman, Birmingham, Ala	27½	11,000.00	24.98	12,490.00
8	Samuel D. Ross, Birmingham, Ala	27	10,800.00	26½	13,250.00
10	McLaughlin Bros., Memphis, Tenn	24	9,600.00	17½	8,750.00
11	John G. Sessions, Hampton, Miss			24.45	12,225.00

No.	Name and address of bidder.	Waterproof (663 R).		Glasscocks, enlargement (726 R).	
		Embankment and excavations, 100,000 cubic yards.	Total cost of levee.	Embankment and excavations, 15,000 cubic yards.	Total cost of levee
		Cents.		*Cents.*	
2	Leeper & Bobbitt, Donaldsonville, La			24	$3,600.00
3	L. M. Dalgarn, Natchez, Miss			*19	2,850.00
7	Davis & Freeman, Birmingham, Ala			25	3,750.00
8	Samuel D. Ross, Birmingham, Ala			25	3,750.00
9	Quinn & Phillips, Red River Landing, La			35	5,250.00
10	McLaughlin Bros., Memphis, Tenn			25	3,750.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Proposals Nos. 10 and 11 were received after the time set for opening bids and were not considered. Waterproof levee withdrawn, being built by State authorities.

Amount available	$78,600
Amount covered by this abstract	17,365
Balance	61,235

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 11, 1893.

. 17.—*Abstract of proposals received in response to advertisement dated September 20, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

PONTCHARTRAIN LEVEE DISTRICT.

	Name and address of bidder.	College Point (905 L).		
		Embankment, 85,000 cubic yards.	Base ditches, etc., 300 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Donovan, Daley & Co., Dreyfus, La	*10.40	*10	$8,870.00
2	The Eltringham Construction Co., Natchez, Miss	12.23	10	10,425.50
4	R. M. Quigley & Co., St. Louis, Mo	13.7	13.7	11,686.10
5	Robert McNamara, New Orleans, La	15½	10	13,205.00
6	Samuel D. Ross, Birmingham, Ala	19	19	16,207.00
7	Chas. T. Worthington, Leota, Miss	18	18	15,354.00
9	Homan & McFadden, Sarpy, La	10.9	10.9	9,297.70
10	Andrews Bros. Construction Co., Baton Rouge, La	13	13	11,089.00
11	Jeffries & Dameron, English Turn, La	14	14	11,942.00
12	George Mercier, New Orleans, La	12.74	12.74	10,867.22
13	James B. Portman, Baton Rouge, La	15½	14	13,004.50
14	J. A. Carson, Baton Rouge, La	18	15	15,345.00
15	Davis & Freeman, Birmingham, Ala	13⅛	8	11,180.25
16	Kane & Hanick, Baton Rouge, La	11.99	11	10,224.50
17	Leeper & Bobbitt, Donaldsonville, La	12⅞	.....	.....

No.	Name and address of bidder.	Reserve (922 L).		
		Embankment, 15,000 cubic yards.	Base ditches, etc., 100 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Donovan, Daley & Co., Dreyfus, La	12.94	10	$1,951.00
2	The Eltringham Construction Co., Natchez, Miss	*12.23	*10	1,844.50
3	D. B. Hearin & Co., Baton Rouge, La	14.20	14.20	2,144.20
5	Robert McNamara, New Orleans, La	17	10	2,560.00
9	Homan & McFadden, Sarpy, La	17	17	2,567.00
10	Andrews Bros. Construction Co., Baton Rouge, La	14½	14½	2,189.50
11	Jeffries & Dameron, English Turn, La	14	14	2,114.00
12	George Mercier, New Orleans, La	12.74	12.74	1,923.74
14	J. A. Carson, Baton Rouge, La	17	15	2,565.00
15	Davis & Freeman, Birmingham, Ala	19½	10	2,935.00
17	Leeper & Bobbitt, Donaldsonville, La	13⅞	.....	.....

BARATARIA LEVEE DISTRICT.

No.	Name and address of bidder.	Myrtle Grove (1,002 R).		
		Embankment, 8,000 cubic yards.	Base ditches, etc., 400 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
2	The Eltringham Construction Co., Natchez, Miss	21	10	$1,720.00
5	Robert McNamara, New Orleans, La	*16	*12	1,328.00
6	Samuel D. Ross, Birmingham, Ala	16.97	16.97	1,425.48
11	Jeffries & Dameron, English Turn, La	25	25	2,100.00
14	J. A. Carson, Baton Rouge, La	18	17	1,508.00
15	Davis & Freeman, Birmingham, Ala	19	10	1,560.00
17	Leeper & Bobbitt, Donaldsonville, La	22	.....	.....

REMARKS.—Proposals marked thus *, being the lowest received and the bidders considered responsible, are recommended for acceptance.

No. 17.—*Abstract of proposals received in response to advertisement dated September 2[illegible], 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River*—Continued.

ATCHAFALAYA RIVER.

No.	Name and address of bidder.	Simmesport, enlargement.	
		Embankment and excavations, 6,000 cubic yards.	Total cost of levee.
		Cents.	
8	F. L. Cason & Co., Odenburg, La	*14.49	$[illegible]
15	Davis & Freeman, Birmingham, Ala	22	1,[illegible]
17	Leeper & Bobbitt, Donaldsonville, La	15.96	[illegible]

REMARKS.—Proposals marked thus *, being the lowest received and the bidders considered responsible, are recommended for acceptance.

	Pontchartrain levee district.	Barataria levee district.	Atchafalaya River.
Amount available	$17,000.00	$20,086.82	$1.00
Amount covered by this abstract	10,714.00	1,328.00	[illegible]
Balance	6,286.00	18,758.82	[illegible]

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 16, 1893.

No. 18.—*Abstract of proposals received in response to advertisement dated October 4, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

LAKE BORGNE LEVEE DISTRICT.

No.	Name and address of persons invited to bid.	Slaughterhouse extension, enlargement and repairs (968.5 L).	
		Embankment and excavations, 3,500 cubic yards.	Total cost of levee.
		Cents.	
1	Robert McNamara, New Orleans, La	22½	$787.50
2	Philip J. Reilly, New Orleans, La	No bid	
3	McLaughlin, Memphis, Tenn	do	

REMARKS.—The bid of Robert McNamara is the only one received. It is considered too high and is therefore not recommended for acceptance.

Amount available ..... $11,416.6[illegible]

No. 18.—*Abstract of proposals received in response to advertisement dated October 4, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River*—Continued.

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Lake Concordia levee.			
		Stations 570 to 597 plus 12 (2,712 linear feet).		Stations 606 plus 52 to 634 plus 33 (2,781 linear feet).	
		Cents.		Cents.	
3	T. G. Bruning & Co., New Orleans, La	75	$2,034.00	75	$2,085.75
8	R. M. Quigley & Co., St. Louis, Mo	63	1,708.56	63	1,752.03
9	Andrews Bros. Construction Co., Baton Rouge, La	*66	1,789.92	*66	1,835.46
		Stations 664 plus 77 to 694 plus 60 (2,983 linear feet).		Stations 694 plus 60 to 725 (3,040 linear feet).	
		Cents.		Cents.	
3	T. G. Bruning, New Orleans, La	75	$2,237.25	75	$2,280.00
8	R. M. Quigley & Co., St. Louis, Mo	63	1,879.29	63	1,915.20
9	Andrews Bros. Construction Co., Baton Rouge, La	*66	1,968.78	*66	2,006.40

REMARKS.—Proposals marked thus *, being the most advantageous and the bidders responsible, are recommended for acceptance. Bid No. 8 (R. M. Quigley & Co.) is the lowest, but as it is a conditional one is not therefore considered.

Amount available	$64,535.39
Amount covered by this abstract	7,600.56
Balance	56,924.83

LAKE BORGNE LEVEE DISTRICT.

No.	Name and address of bidder.	Battle ground (5,093 linear feet).		Repose (700 linear feet).		St. Clair (4,300 linear feet).	
		Cents.		Cents.		Cents.	
1	H. W. Gribble, New Orleans, La	68⅜	$3,482.34			72⅜	$3,112.12
2	Alfred Pierson, New Orleans, La	75	3,819.75	75	$525.00	75	3,225.00
3	T. G. Bruning, New Orleans, La	63.49	3,223.55			63.49	2,730.07
4	Robert McNamara, New Orleans, La	63	3,208.59	65	455.00	65	2,795.00
5	John Cleary, New Orleans, La	68	3,463.24	70	490.00	66	2,838.00
6	Robert McNamara, jr., New Orleans, La	56	2,953.94	58	406.00	*60	2,580.00
7	James Byrne, Baton Rouge, La	*56	2,852.08	*56	393.00	60	2,580.00
8	R. M. Quigley & Co., St. Louis, Mo	63	3,208.59	63	441.00	63	2,709.00
9	Andrews Bros. Construction Co., Baton Rouge, La	66	3,361.38	66	462.00	66	2,838.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders responsible, are recommended for acceptance. The proposals of Robert McNamara, jr., and James Byrne on St. Clair being the same, it was agreed by them that Mr. McNamara, jr., should do the work.

Amount available	$10,294.38
Amount covered by this abstract	5,824.08
Balance	4,470.30

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 1, 1893.

No. 19.—*Abstract of proposals received in response to advertisement dated November 21, 1893, opened this day by Capt John Millis, Corps of Engineers, for the revetment of levees in the fourth district, improving Mississippi River.*

BARATARIA LEVEE DISTRICT

No.	Name and address of bidder.	Fort St. Leon middle levee (1,500 linear feet).		Belle Chasse to Concession levee (200 linear feet).		Oakville levee (2,752 linear feet).		Happy Point levee (700 linear feet).	
		Cents.		Cents.		Cents.		Cents.	
1	H. W. Gribble, New Orleans, La	74½	$1,115.62			74½	$2,046.80		
2	Alfred Pierson, New Orleans, La	75	1,125.00	80	$160.00	75	2,064.00	75	$525.00
3	T. G. Bruning, New Orleans, La	*63.49	952.35			63.49	1,747.25		
4	Robert McNamara, New Orleans, La	67	1,005.00	68	136.00	66	1,816.32	67	469.00
8	R. M. Quigley & Co., St. Louis, Mo	63	945.00	63	126.00	63	1,733.76	63	441.00
9	Andrews Bros. Construction Co., Baton Rouge, La	66	990.00	*66	132.00	66	1,816.32	66	462.00
10	George E Corbette, Algiers, La	85	1,275.00	90	180.00	75	2,064.00	80	560.00

No.	Name and address of bidder.	Star levee (3,218 linear feet).		Ironton levee (2,043 linear feet).		Oakland levee (2,000 linear feet).	
		Cents.		Cents.		Cents.	
1	H. W. Gribble, New Orleans, La	74½	$2,393.39	75½	$1,539.91	75½	$1,515.00
2	Alfred Pierson, New Orleans, La	75	2,413.50	75	1,532.25	75	1,500.00
3	T. G. Bruning, New Orleans, La	63.49	2,043.11	63.49	1,297.10	63.49	1,269.80
4	Robert McNamara, New Orleans, La	67	2,156.06	67	1,368.81	67	1,340.00
8	R. M. Quigley & Co., St. Louis, Mo	63	2,027.34	63	1,287.09	63	1,260.00
9	Andrews Bros. Construction Co., Baton Rouge, La	66	2,123.88	66	1,348.38	66	1,320.00
10	George E. Corbette, Algiers, La	78	2,510.04	75	1,532.25	75	1,500.00

REMARKS.—Proposals marked thus *, being the most advantageous and the bidders responsible are recommended for acceptance. Bid No. 8 (R. M. Quigley & Co.) is the lowest, but it is a conditional one and is not, therefore, considered.

Amount available	$17,241.69
Amount covered by this abstract	7,903.61
Balance	9,337.88

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 20, 1893.

No. 20.—*Abstract of proposals received in response to advertisement dated December 7, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levee in the fourth district, improving Mississippi River.*

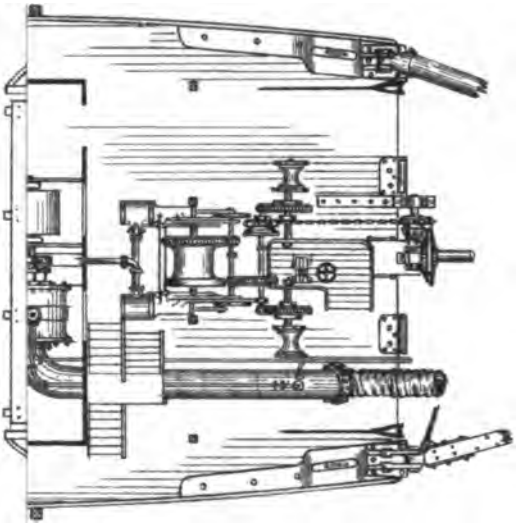
LOWER TENSAS LEVEE DISTRICT.

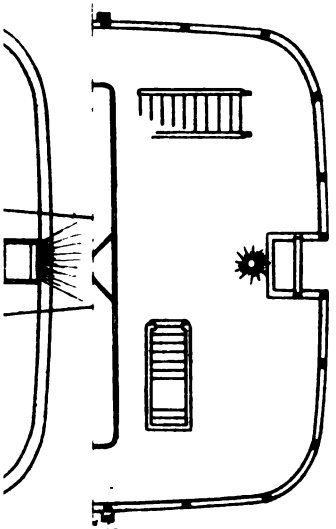
No.	Name and address of bidder.	Forest Home (723 R).		
		Embankment, 100,000 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.
		Cents.	Cents.	
1	Starling & Smith Co., Greenville, Miss	14½	14½	$14,228.40
2	John Scott & Sons, St. Louis, Mo	16.74	8	16,756.00
3	Manning & Gibson, Vicksburg, Miss	*10	*10	10,020.00
4	Homan & McFadden, Welcome, La	13½	13½	13,527.00
5	Jeffries & Dameron, Junior, La	18	18	18,036.00

REMARKS.—Proposal marked thus *, is the lowest received and the bidders responsible, is recommended for acceptance.

Amount available	$56,934.33
Amount covered by this abstract	10,020.00
Balance	46,914.33

PLATE I.





Drawn by N.A. Moran.

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No. 1 (1895).—*Abstract of proposals received in response to advertisement dated October 21, 1895, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving the Mississippi River*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.		Lake Borgne levee district.	
		Towles to Billings, enlargement.		Sugarhouse.	
		Embankment, 15,000 cubic yards.	Total cost of levee.	Embankment, 8,500 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Jeffries & Dameron, English Turn, La	18	$1,950.00	18	$1,530.00
2	Jno. J. Frawley, New Orleans, La			18.97	1,614.45
3	Israel R. Bobbitt, Egg Bend, La	15½	2,325.00	*14½	1,232.50
4	R. M. Quigley & Co., St. Louis, Mo	*11.47	1,720.50	25	2,125.00
5	The Eltringham Construction Co., Natchez, Miss	13.45	2,017.50	18	1,530.00
6	Henry D. Corbett, Jesuits Bend, La			17.49	1,486.65
7	James N. Ogden, Baton Rouge, La	16.74	2,511.00		
8	T. W. Scott & Co., Baton Rouge, La	12	1,800.00		
9	Davis & Freeman, Birmingham, Ala	16.98	2,547.00	17.97	1,527.45
10	Andrews Bros. Construction Co., Baton Rouge, La	14.47	2,170.50	15.20	1,292.00
11	Donovan, Daley & Co., Baton Rogue, La	15.90	2,385.00	17	1,445.00
12	Edwin B. Helgason, Natchez, Miss				
13	Manning & Gibson, Natchez, Miss	14	2,100.00		
14	Robert R. Colquitt, Shreveport, La	20	3,000.00		
15	William L. Killebrew, Memphis, Tenn	13.99	2,098.50		
16	Hayes Bros., Welcome, La	18	2,700.00	20	1,700.00
17	John Mahoney, Kansas City, Kans			16.85	1,432.25
18	John Scott & Sons, St. Louis, Mo	18	2,700.00		
19	George Mercier, New Orleans, La	14¼	2,137.50	15	1,275.00
20	McLaughlin Bros., Memphis, Tenn	13.98	2,097.00	11.98	1,272.50
21	Charles T. Worthington, Leota, Miss	17	2,550.00	18	1,530.00
22	S. D. Moody & Co., Limited, New Orleans, La			16	1,360.00
23	Homan & McFadden, Sarpy, La	14.8	2,200.00		

No.	Name and address of bidder.	Lake Borgne levee district.			
		Merritt.		Stella.	
		Embankment, 32,000 cubic yards.	Total cost of levee.	Embankment, 22,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Jeffries & Dameron, English Turn, La	15	$4,800.00	*13	$2,860.00
2	Jno. J. Frawley, New Orleans, La	15.49	4,956.80	14.99	3,297.80
3	Israel R. Bobbitt, Egg Bend, La	14½	4,720.00	15.1	3,322.00
4	R. M. Quigley & Co., St. Louis, Mo	24.48	7,833.60	24.48	5,385.60
5	The Eltringham Construction Co., Natchez, Miss	17	5,440.00	17	3,740.00
6	Henry D. Corbett, Jesuits Bend, La	17.49	5,596.80	16.98	3,735.60
9	Davis & Freeman, Birmingham, Ala	16.20	5,184.00	16.18	3,559.60
10	Andrews Bros. Construction Co., Baton Rouge, La	15.20	4,864.00	13.74	3,022.80
11	Donovan, Daley & Co., Baton Rouge, La	22	7,040.00	24	5,280.00
13	Manning & Gibson, Natchez, Miss	16	5,120.00	16	3,520.00
15	William L. Killebrew, Memphis, Tenn			17.9	3,938.00
16	Hayes Bros., Welcome, La	18	5,760.00	17	3,740.00
17	John Mahoney, Kansas City, Kans	*13.85	4,432.00	13.85	3,047.00
19	George Mercier, New Orleans, La	14.95	4,784.00	15	3,300.00
20	McLaughlin Bros., Memphis, Tenn	17	5,440.00	14¾	3,245.00
21	Charles T. Worthington, Leota, Miss	15	4,800.00	14½	3,190.00
22	S. D. Moody & Co., Limited, New Orleans, La	16	5,120.00	16	3,520.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders responsible, are recommended for acceptance.

	Pontchartrain levee district.	Lake Borgne levee district.
Amount available	$150,000.00	$50,000.00
Amount covered by this abstract	9,061.30	8,524.50
Balance	140,938.70	41,475.50

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 7, 1893.

o. 2 (1895).—***Abstract of proposals received in response to advertisement dated October 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.***

o.	Name and address of bidder.	Pontchartrain levee district.			
		Grenada, enlargement.		Sunshine.	
		Embankment, 24,000 cubic yards.	Total cost of levee.	Embankment, 40,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	The Eltringham Construction Co., Natchez, Miss..	12½	$3,000.00	13.45	$5,380.00
2	W. L. Killberew, Memphis, Tenn.....	14⅜	3,450.00	14.99	5,996.00
3	Starling & Smith Co., Greenville, Miss.....	13¾	3,280.00	13½	5,300.00
4	James N. Ogden, Baton Rouge, La.....	12.70	3,048.00	14.70	5,880.00
5	James M. Sullivan, Memphis, Tenn.....	13.23	3,175.20	14.43	5,772.00
6	Manning & Gibson, Villa Vista, La.....	11½	2,700.00	12.94	5,176.00
7	R. M. Quigley & Co., St. Louis, Mo	12.93	3,103.20	12.39	4,956.00
8	Edwin B. Helgason, Natchez, Miss	16	3,840.00	17	6,800.00
9	Robt. K. Colquitt, Shreveport, La	14.47	3,472.80	15.97	6,388.00
0	Donovan, Daley & Co., Baton Rouge, La.....	12.40	2,976.00	12.40	4,960.00
1	John Mahoney, Kansas City, Kans	17.84	4,281.60	14	5,600.00
2	Michael Hanick, St. Louis, Mo	13	3,120.00	12½	5,000.00
3	Hayes Bros., Welcome, La.....	16	3,840.00	15	6,000.00
4	T. W. Scott & Co., Baton Rouge, La.....	12	2,880.00	*12	4,800.00
5	Andrews Bros. Construction Co., Baton Rouge, La.	13	3,120.00	13	5,200.00
6	Homan & McFadden, Sarpy, La.....	11.90	2,856.00	13.60	5,440.00
7	Davis & Freeman, Birmingham, Ala.....	13.40	3,216.00	13.03	5,320.00
8	D. B. Hearin & Co., Baton Rouge, La.....			14.70	5,880.00
9	Jeffries & Dameron, English Turn, La.....	*10	2,400.00	12¾	5,100.00
0	George Mercier, New Orleans, La.....	12.24	2,937.60	13.24	5,296.00
1	Israel R. Bobbitt, Egg Bend, La	18	4,320.00	15.45	6,180.00
2	John Scott & Sons, St. Louis, Mo	14.45	3,468.00	14.97	5,988.00
3	Chas. T. Worthington, Leota, Miss	17	4,080.00	15¼	6,200.00

o.	Name and address of bidder.	Pontchartrain levee district.			
		Virginia.		Lorio.	
		Embankment, 36,000 cubic yards.	Total cost of levee.	Embankment, 10,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	The Eltringham Construction Co., Natchez, Miss..	13	$4,680.00	12	$1,200.00
2	William L. Killebrew, Memphis, Tenn	14.43	5,194.80	13.93	1,393.00
3	Starling & Smith Co., Greenville, Miss.....	13	4,680.00	12½	1,225.00
4	James N. Ogden, Baton Rouge, La.....	12.99	4,676.40	13.99	1,399.00
5	James M. Sullivan, Memphis, Tenn.....	13.41	4,827.60	13.22	1,322.00
6	Manning & Gibson, Villa Vista, La.....	14.94	5,378.40	14.93	1,493.00
7	R. M. Quigley & Co., St. Louis, Mo.....	12.39	4,460.00	11.93	1,193.00
8	Edwin B. Helgason, Natchez, Miss	12.75	4,590.00	15	1,500.00
9	Robert K. Colquitt, Shreveport, La.....	14.47	5,209.20		
10	Donovan, Daley & Co., Baton Rouge, La	10.40	4,104.00	12.90	1,290.00
11	John Mahoney, Kansas City, Kans	14.83	5,338.80	16	1,600.00
12	Michael Hanick, St. Louis, Mo.....	13	4,680.00	12½	1,250.00
13	Hayes Bros., Welcome, La.....	15	5,400.00	15	1,500.00
14	T. W. Scott & Co., Baton Rouge, La.....	12	4,320.00	12	1,200.00
15	Andrews Bros. Construction Co., Baton Rouge, La..	13	4,680.00	14	1,400.00
16	Homan & McFadden, Sarpy, La	12.70	4,572.00	14	1,400.00
17	Davis & Freeman, Birmingham, Ala.....	13.30	4,788.00	14.30	1,430.00
18	D. B. Hearin & Co., Baton Rouge, La.....	14½	5,220.00	15	1,500.00
19	Jeffries & Dameron, English Turn, La.....	12½	4,860.00	15	1,500.00
20	George Mercier, New Orleans, La.....	13.44	4,838.00	13.44	1,344.00
21	Israel R. Bobbitt, Egg Bend, La.....	13¾	4,950.00	14¾	1,475.00
22	John Scott & Sons, St. Louis, Mo.....	14.45	5,202.00	14.45	1,445.00
23	Charles T. Worthington, Leota, Miss.....	14¾	5,310.00	18	1,800.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Bid No. 23 received after the time set for the opening of bids.

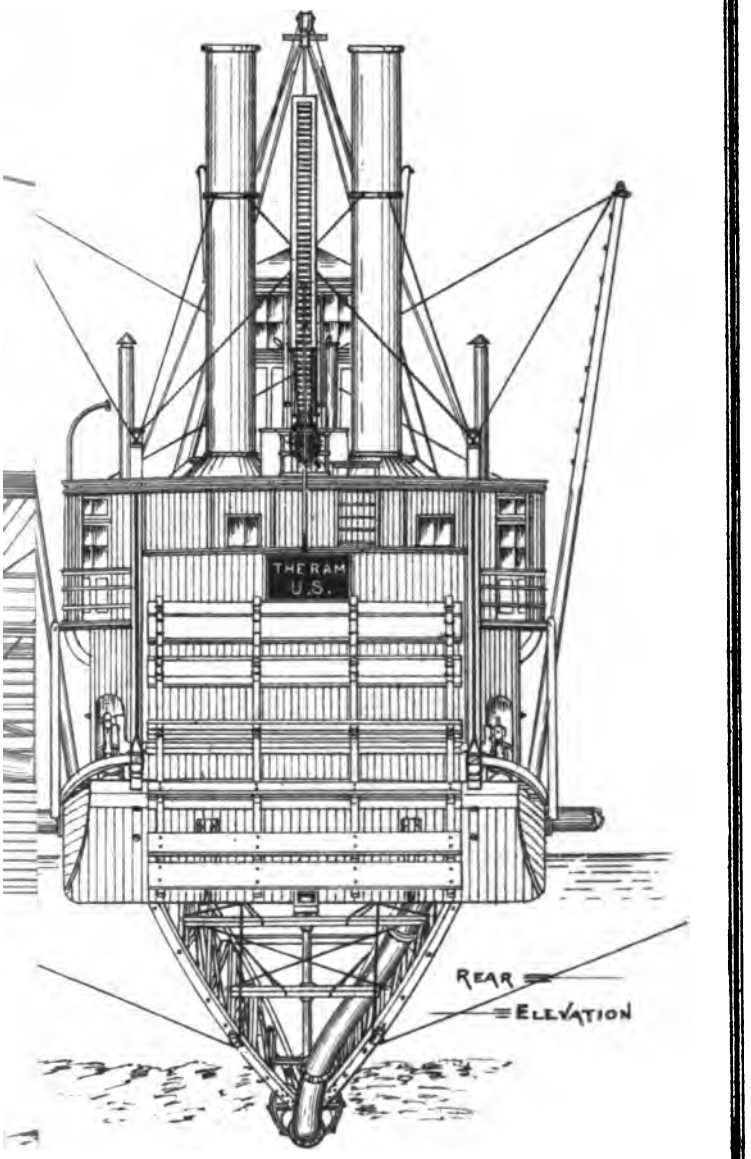
No. 2 (1895).—*Abstract of proposals received in response to advertisement dated October 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving the Mississippi River*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.			
		Point Clear.		Point Clear, lower.	
		Embankment, 16,000 cubic yards.	Total cost of levee.	Embankment, 40,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	The Eltringham Construction Co., Natchez, Miss	12	$1,920.00	13.45	$5,380.00
2	William L. Killebrew, Memphis, Tenn	13⅜	2,140.00	12.99	5,196.00
3	Starling & Smith Co., Greenville, Miss	12¼	1,960.00	12⅞	5,150.00
4	James N. Ogden, Baton Rouge, La	13.99	2,238.40	14.70	5,880.00
5	James M. Sullivan, Memphis, Tenn	14.17	2,267.20	15.23	6,092.00
6	Manning & Gibson, Villa Vista, La	12.99	2,078.40	15.24	6,096.00
7	R. M. Quigley & Co., St. Louis, Mo	11.93	1,908.80	12.93	5,172.00
8	Edwin B. Helgason, Natchez, Miss				
9	Robert K. Colquitt, Shreveport, La	19¾	3,160.00	14.98	5,992.00
10	Donovan, Daley & Co., Baton Rouge, La	*11.40	1,824.00	*9.90	3,960.00
11	John Mahoney, Kansas City, Kans	15.94	2,550.40	17.64	7,056.00
12	Michael Hanick, St. Louis, Mo	13	2,080.00	12	4,800.00
13	Hayes Bros., Welcome, La	14	2,240.00	14	5,600.00
14	T. W. Scott & Co., Baton Rouge, La	12	1,920.00	12	4,800.00
15	Andrews Bros. Construction Co., Baton Rouge, La	13	2,080.00	13	5,200.00
16	Homan & McFadden, Sarpy, La	12.4	1,984.00	12	4,800.00
17	Davis & Freeman, Birmingham, Ala	14	2,240.00	13.35	5,340.00
18	D. B. Hearin & Co., Baton Rouge, La				
19	Jeffries & Dameron, English Turn, La	11½	1,840.00	10½	4,200.00
20	George Mercier, New Orleans, La	13.44	2,150.40	12.94	5,176.00
21	Israel R. Bobbitt, Egg Bend, La	14½	2,320.00	16	6,400.00
22	John Scott & Sons, St. Louis, Mo	14.97	2,395.20	10.99	7,396.00
23	Charles T. Worthington, Leota, Miss	17	2,720.00	15	6,000.00

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Bid No. 23 received after the time set for the opening of bids.

Amount available	$140,938.71
Amount covered by this abstract	18,281.00
Balance	122,657.71

PLATE III



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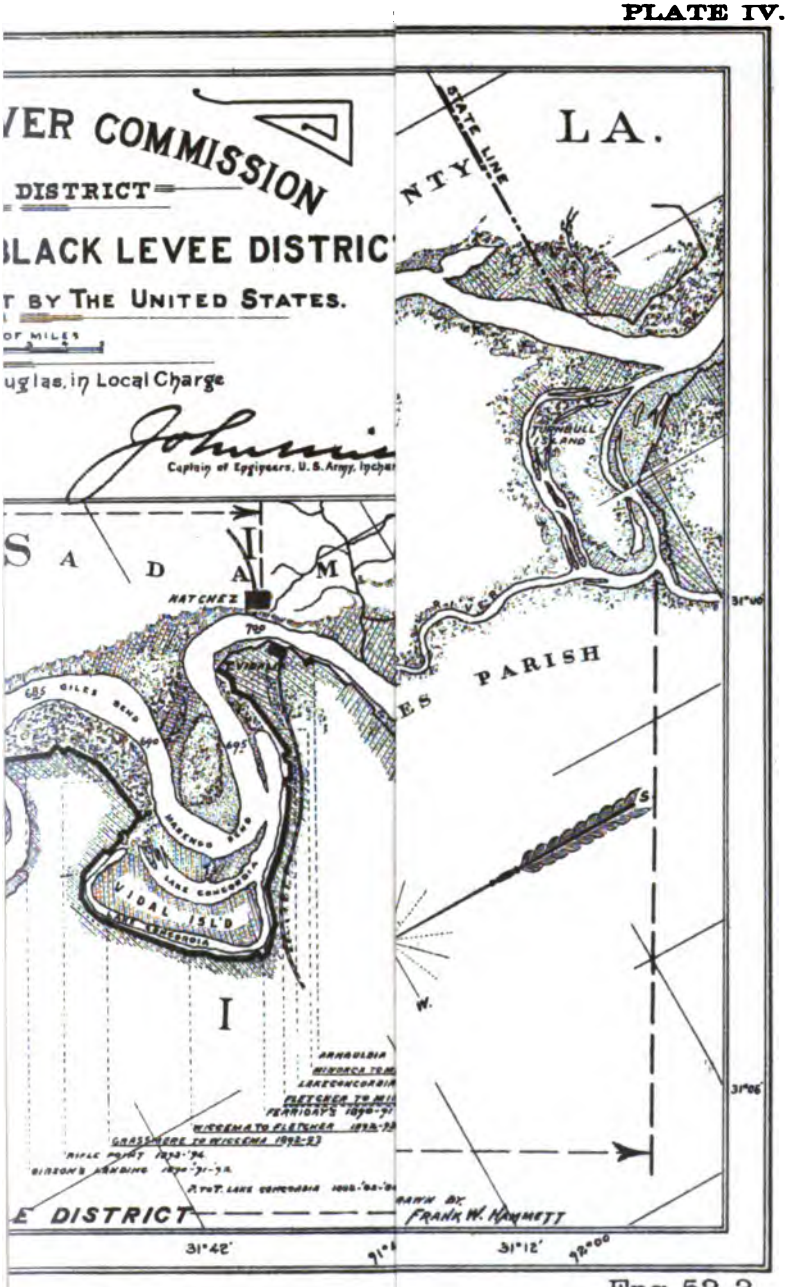
No. 3 (1895).—*Abstract of proposals received in response to advertisement dated October 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.			
		Uncle Sam.		Longue Vue.	
		Embankment, 50,000 cubic yards.	Total cost of levee.	Embankment, 30,000 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	
1	Manning & Gibson, Villa Vista, La	11.97	$5,985.00	11.97	$3,59[illegible]
2	James M. Sullivan, Memphis, Tenn	15.74	7,870.00	13.32	3,99[illegible]
3	John Scott & Sons, St. Louis, Mo	14.87	7,435.00	14.45	4,33[illegible]
4	William L. Killebrew, Memph'is, Tenn	13.93	6,965.00	12.93	4,17[illegible]
5	Davis & Freeman, Birmingham, Ala	12⅞	6,437.50	13.47	4,04[illegible]
6	Jehries & Dameron, English Turn, La	12	6,000.00	12½	3,75[illegible]
7	C. D. Leeper, Donaldsonville, La	13.2	6,600.00		
8	Michael Hanick, St. Louis, Mo	12½	6,250.00	12	3,60[illegible]
9	The Eltringham Construction Co., Natchez, Miss	12	6,000.00	12	3,60[illegible]
10	Israel R. Bobbitt, Egg Bend, La	14.74	7,370.00	13¾	4,12[illegible]
11	Donovan, Daley & Co., Baton Rouge, La	12.99	6,495.00	11.97	3,59[illegible]
13	John Mahoney, Kansas City, Kans	14.45	7,225.00	15	4,5[illegible]
14	T. W. Scott & Co., Baton Rouge, La	13	6,500.00	12	3,6[illegible]
15	Starling & Smith Co., Greenville, Miss	12½	6,187.50	13½	4,0[illegible]
16	John A. Carson, Baton Rouge, La	12½	6,250.00	12	3,6[illegible]
17	J. S. McTighe & Co., Memphis, Tenn	14½	7,250.00	15	4,5[illegible]
18	R. M. Quigley & Co., St. Louis, Mo	*11.39	5,695.00	*11.39	3,41[illegible]
19	Homan & McFadden, Sarpy, La	12	6,000.00	13	3,9[illegible]
20	James N. Ogden, Baton Rouge, La	13.90	6,950.00	12.90	3,8[illegible]
21	George Mercier, New Orleans, La	13.40	6,700.00	13	3,9[illegible]
22	D. B. Hearin & Co., Baton Rouge, La	13	6,500.00	13½	4,0[illegible]
23	Andrews Bros. Construction Co., Baton Rouge, La	12.92	6,460.00	14	4,2[illegible]
24	Chas. T. Worthington, Leota, Miss	14½	7,250.00	14½	4,3[illegible]

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance. Bid No. 24 received after the time set for opening of bids, and is therefore not considered. No bid recommended for acceptance on the Revenue levee, enlargement, etc., caving of bank will necessitate change in plan of work and increased quantity.

Amount available	$122 6[illegible]
Amount covered by this abstract	18,[illegible]
Balance	103,5[illegible]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Eng 53 3

No. 4 (1895).—*Abstract of proposals received in response to advertisement dated October 21, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district—Frellsen.	
		Embankment, 23,000 cubic yards.	Total cost of levee.
		Cents.	
1	Homan & McFadden, Sarpy, La	12.8	[illegible]
3	James M. Sullivan, Memphis, Tenn	13.23	[illegible]
4	W. L. Killebrew, Memphis, Tenn	14.97	[illegible]
5	T. W. Scott & Co., Baton Rouge, La	12½	[illegible]
6	Andrews Bros. Construction Co., Baton Rouge, La	13	[illegible]
7	The Eltringham Construction Co., Natchez, Miss	13.90	[illegible]
8	Manning & Gibson, Villa Vista, La	11	[illegible]
9	John Scott & Sons, St. Louis, Mo	14.93	[illegible]
10	Joseph S. Codifer, New Orleans, La	18	[illegible]
11	Michael Hanick, St. Louis, Mo	14	[illegible]
12	R. M. Quigley & Co., St. Louis, Mo	17	[illegible]
13	J. S. McTighe & Co., Memphis, Tenn	14.90	[illegible]
14	Hayes Bros., Welcome, La	10½	[illegible]
15	Jeffries & Dameron, English Turn, La	13½	[illegible]
16	Chas. T. Worthington, Leota, Miss	16	[illegible]
17	Israel R. Bobbitt, Egg Bend, La	14.90	[illegible]
19	George Mercier, New Orleans, La	13.88	[illegible]
20	John Mahoney, Kansas City, Kans	14.84	[illegible]
21	Donovan, Daley & Co., Dreyfus, La	10.90	[illegible]
22	Edwin B. Helgason, Natchez, Miss	14	[illegible]
23	John A. Carson, Baton Rouge, La	13	[illegible]
24	James N. Ogden, Baton Rouge, La	13.99	[illegible]
25	Davis & Freeman, Birmingham, Ala	13½	[illegible]

REMARKS.—Proposals marked thus *, being the lowest and the bidders considered responsible, are recommended for acceptance.

Amount available ..... $105,[illegible]
Amount covered by this abstract ..... 14,[illegible]

Balance ..... [illegible]

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 30, 1893.

No. 5 (1895).—*Abstract of proposals received in response to advertisement dated December 16, 1893, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district—Revenue.	
		Embankment 45,000 cubic yards.	Total cost of levee.
		Cents.	
1	McLaughlin Bros., Memphis, Tenn	15	$6,750.00
2	W. L. Killebrew, Searcy, Ark	12.9	5,805.00
3	C. D. Leeper, Convent, La	13	5,850.00
4	Donovan, Daley & Co., Baton Rouge, La	*11.39	5,125.50
5	W. J. Bentley & Co., New Orleans, La	12⅛	5,512.50
6	Israel R. Bobbitt, Egg Bend, La	16⅛	7,425.00
7	R. M. Quigley & Co., St. Louis, Mo	12.93	5,815.50
8	J. A. Carson, Baton Rouge, La	14⅛	6,525.00
9	Appel & Cullen, Port Allen, La	13.45	6,052.50
10	Alexander Eltringham, Natchez, Miss	12.23	5,953.50
11	Michael Hanick & Co., Baton Rouge, La	12	5,400.00
12	Andrews Bros. Construction Co., Baton Rouge, La	12	5,400.00
14	Homan & McFadden, Welcome, La	13.9	6,225.00

No.	Name and address of bidder.	Lake Borgne levee district—Greenwood levee.		
		Embankment 42,000 cubic yards.	Base ditches, etc., 1,500 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	McLaughlin Bros., Memphis, Tenn	13	13	$5,655.00
2	W. L. Killebrew, Searcy, Ark	13⅜	13⅜	5,818.32
3	C. D. Leeper, Convent, La	15	15	6,525.00
4	Donovan, Daley & Co., Baton Rouge, La	*12.90	*10	5,568.00
5	W. J. Bentley & Co., New Orleans, La	14⅛	14⅛	6,307.50
6	Israel R. Bobbitt, Egg Bend, La	15	10	6,450.00
7	J. A. Carson, Baton Rouge, La	13⅛	13⅛	5,872.50
12	Andrew Bros. Construction Co., Baton Rogue, La	14⅜	14⅜	6,416.25
13	Robt. McNamara, New Orleans, La	14	14	6,090.00

REMARKS.—Proposals marked thus *, is the lowest received and the bidders responsible, is recommended for acceptance.

	Pontchartrain levee district.	Lake Borgne levee district.
Amount available	$88,774.20	$41,475.50
Amount covered by this abstract	5,125.50	5,568.00
Balance	83,648.70	35,907.50

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 15, 1894.

No. 6 (1895).—*Abstract of proposals received in response to advertisement dated January 30, 1894, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district—Bay Point, new and enlargement.		
		Embankment, 36,000 cubic yards.	Base ditches, etc., 300 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Israel R. Bobbitt, Dreyfus, La	13½	10	$4.[illegible]
2	Edwin B. Helgason, Natchez, Miss	* 8. 95	* 8. 95	3.[illegible]
3	R. M. Quigley & Co., St. Louis, Mo	9. 89	10	3.[illegible]
5	The Eltringham Construction Co., Natchez, Miss	10. 43	6	3.[illegible]
6	Homan & McFadden, Baton Rouge, La	9. 7	9. 7	3.[illegible]
7	Hayes Bros., Killona, La	9. 99	.....	3,566.[illegible]
10	Michael Hanick, St. Louis, Mo	13	12	4.[illegible]
11	Manoah V. Henry, Birmingham, Ala	21	21	7.[illegible]
12	Manning & Gibson, Natchez, Miss	12. 99	12. 99	4.[illegible]

No.	Name and address of bidder.	Pontchartrain levee district.					
		Dennis.			Venus.		
		Embankment, 17,500 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.	Embankment, 16,000 cubic yards.	Base ditches, etc., 250 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Israel R. Bobbitt, Dreyfus, La	13½	10	$2,426.25	14½	10	$2.[illegible]
2	Edwin B. Helgason, Natchez, Miss	9. 45	9. 45	1,672.65	12	12	1.[illegible]
5	The Eltringham Construction Co., Natchez, Miss	* 9. 23	* 5	1,625.25	* 11	7	1.[illegible]
6	Homan & McFadden, Baton Rouge, La	11	11	1,947.00	15½	15½	2.[illegible]
7	Hayes Bros., Killona, La	15	.....	2,625.00	16	.....	2.[illegible]
8	Donovan, Daley & Co., Baton Rouge, La	9. 39	9	1,661.25	11. 94	9	1.[illegible]
9	James Byrne, Baton Rouge, La	15½	15½	2,743.50	.....	.....	.....
10	Michael Hanick, St. Louis, Mo	13	12	2,299.00	13	12	2.[illegible]
11	Manoah V. Henry, Birmingham, Ala	21	21	3,717.00	23	23	3.[illegible]
12	Manning & Gibson, Natchez, Miss	13. 24	13. 24	2,342.48	13. 74	13. 74	2.[illegible]

No.	Name and address of bidder.	Barataria levee district—Live Oak extension.		
		Embankment, 6,500 cubic yards.	Base ditches, etc., 900 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	Israel R. Bobbitt, Dreyfus, La	16	12	$1,14[illegible]
4	Pat Harman, New Orleans, La	21½	19½	1,57[illegible]
8	Donovan, Daley & Co., Baton Rouge, La	* 13. 94	* 10	99[illegible]
9	James Bryne, Baton Rouge, La	15½	15½	1,16[illegible]
11	Manoah V. Henry, Birmingham, Ala	27	27	1,99[illegible]
13	Robt. McNamara, New Orleans, La	16½	15	1,20[illegible]

REMARKS.—Proposals marked thus *, being the lowest received and the bidders considered responsible, are recommended for acceptance.

	Pontchartrain levee district.	Barataria levee district.
Amount available	$83,648.70	$60,000.00
Amount covered by this abstract	6,651.60	998.10
Balance	76,997.10	59,001.90

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 23, 1894.

7 (1895).—*Abstract of proposals received in response to advertisement dated February 10, 94, opened this day by Capt. John Millis, Corps of Engineers, for the construction of rees in the fourth district, improving Mississippi River.*

Name and address of bidder.	Pontchartrain levee district.					
	Convent.			Sport.		
	Embankment, 42,000 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.	Embankment, 17,000 cubic yards.	Base ditches, etc., 200 cubic yards.	Total cost of levee.
	Cents.	*Cents.*		*Cents.*	*Cents.*	
John Scott & Sons, St. Louis Mo	14	10	$5,930.00	14	10	$2,400.00
Donovan, Daley & Co., Baton Rouge, La	9.30	9	3,988.80	10.90	8	1,869.00
The Eltringham Construction Co., Natchez, Miss	10	10	4,250.00	12½	12½	2,107.00
Israel R. Bobbitt, Convent, La.	12⅝	12	5,467.50	14½	12	2,489.00
Manning & Gibson, Natchez, Miss	10.94	10.94	4,649.51	*10.74	*10.94	1,847.28
Edwin B. Helgason, Natchez, Miss	12	12	5,100.00	13	13	2,236.00
W. J. Bentley & Co., New Orleans, La	13.19	13.19	5,605.75	13.19	13.19	2,268.68
Homan & McFadden, Baton Rouge, La	11.8	11.8	5,015.00	13	10	2,230.00
J. A. Carson, Morville, La	14	14	5,950.00	13	13	2,236.00
Porter & Stamps, Kenner, La.	10.95	10.95	4,653.75	10.95	10.95	1,883.40
J. S. Codifer & Co., New Orleans	14½	.....	6,090.00	12	.....	2,040.00
Arnold & DeGaris, Memphis, Tenn	16	17	6,805.00	21	22	3,614.00
C. D. Leeper & Co., Convent, La	*8.97	*8.97	3,812.25	12	11	2,062.00
M. Hanick & Co., Baton Rouge, La	12	12	5,100.00	13	12	2,234.00

Name and address of bidder.	Atchafalaya levee district.					
	St. Louis.			Old Hickory.		
	Embankment, 109,500 cubic yards.	Base ditches, etc., 1,500 cubic yards.	Total cost of levee.	Embankment, 30,300 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.
	Cents.	*Cents.*		*Cents.*	*Cents.*	
John Scott & Sons, St. Louis, Mo	12.74	10	$14,100.30	12.74	10	$3,910.22
Donovan, Daley & Co., Baton Rouge, La	13.90	8	15,340.50	*9.90	*8	3,339.70
The Eltringham Construction Co., Natchez, Miss	14	14	15,540.00	13	13	4,004.00
Israel R. Bobbitt, Convent, La	13⅞	12	15,373.12	13½	12	4,150.50
Manning & Gibson, Natchez, Miss	11.45	11.20	12,705.75	12	12	3,696.00
Edwin B. Helgason, Natchez, Miss	14	14	15,540.00	10½	10½	3,234.00
W. J. Bentley & Co., New Orleans, La	13.19	13.19	14,640.90	13.19	13.19	4,062.52
Homan & McFadden, Baton Rouge, La	12	12	13,320.00	11.07	10	3,595.10
J. A. Carson, Morville, La	14½	14½	16,095.00	12	12	3,696.00
Arnold & De Garis, Memphis, Tenn	16½	15	18,018.75	18	18	5,544.00
C. D. Leeper & Co., Convent, La.	13½	10	14,658.75	12.01	10	3,716.30
M. Hanick & Co., Baton Rouge, La	*11	*11	12,210.00	12	12	3,696.00

	Pontchartrain levee district.	Atchafalaya levee district.
ount available	$76,997.10	$152,000.00
ount covered by this abstract	5,659.53	15,249.70
Balance	71,337.57	136,750.30

EMARKS.—Proposals marked thus *, are the lowest received and, the bidders being responsible, are ommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 2, 1894.

No. 8 (1895).—*Abstract of proposals received in response to advertisement dated February 15, 1894, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Atchafalaya levee district—Lakeland.		
		Embankment, 29,500 cubic yards.	Base ditches, etc., 100 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
1	John T. Martin, Shreveport, La	10.95	8.95	$3,728.25
2	James M. Sullivan, Memphis, Tenn	13.23	13.23	3,914.[illegible]
3	Hayes Bros., Bonnet Carre, La	12	12	3,552.[illegible]
4	John Scott & Sons, St. Louis, Mo	13.93	10	4,139.[illegible]
6	W. J. Bentley & Co., New Orleans, La	12⅝	12⅝	3,774.69
7	The Eltringham Construction Co., Natchez, Miss	11	10	3,256.00
8	N. P Phillips, Red River Landing, La	12.99	15	3,867.07
11	Michael Hanick & Co., Baton Rouge, La	15	12	4,457.50
12	Manning & Gibson, Natchez, Miss	11.74	11.74	3,475.[illegible]
13	Hartnett & O'Brien, Point Coupee, La	11.98	11.98	3,546.[illegible]
14	Edwin B. Helgason, Natchez, Miss	*9.90	*9.90	2,930.[illegible]

No.	Name and address of bidder.	Atchafalaya levee district—Poplar Grove, upper		
		Embankment, 36,400 cubic yards.	Base ditches, etc., 300 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
2	James M. Sullivan, Memphis, Tenn	12.73	12.73	$4,071.[illegible]
3	Hayes Bros., Bonnet Carre, La	11	11	4,067.[illegible]
4	John Scott & Sons, St. Louis, Mo	12.45	10	4,561.[illegible]
5	Homan & McFadden, Baton Rouge, La	11	10	4,854.[illegible]
6	W. J. Bentley & Co., New Orleans, La	12⅝	12⅝	4,619.[illegible]
7	The Eltringham Construction Co., Natchez, Miss	11.43	10	4,139.[illegible]
8	N. P. Phillips, Red River Landing, La	15	15	5,565.[illegible]
9	Donovan, Daley & Co., Baton Rouge, La	*10.70	*8	3,91[illegible]
11	Michael Hanick & Co., Baton Rouge, La	13	13	4,771.[illegible]
12	Manning & Gibson, Natchez, Miss	10.94	10.94	4,014.[illegible]
13	Hartnett & O'Brien, Point Coupee, La	11.98	11.98	4,396.[illegible]
14	Edwin B. Helgason Natchez, Miss	12	11	4,401.[illegible]

No.	Name and address of bidder.	Atchafalaya levee district—Poplar Grove, lower.		
		Embankment, 41,250 cubic yards.	Base ditches, etc., 500 cubic yards	Total cost of levee.
		Cents.	*Cents.*	
2	James M. Sullivan, Memphis, Tenn	14½	14½	$6,053.75
3	Hayes Bros., Bonnet Carre, La	*10⅛	*10⅛	4,387.75
4	John Scott & Sons, St. Louis, Mo	12.45	10	5,[illegible]
5	Homan & McFadden, Baton Rouge, La	12	10	5,00[illegible]
6	W. J. Bentley & Co., New Orleans, La	12⅝	12⅝	5,323.12
7	The Eltringham Construction Co., Natchez, Miss	11.23	10	4,682.[illegible]
8	N. P. Phillips, Red River Landing, La	16	16	6,640.00
9	Donovan, Daley & Co., Baton Rouge, La	10.70	8	4,453.75
11	Michael Hanick & Co., Baton Rouge, La	14	12	5,835.00
12	Manning & Gibson, Natchez, Miss	10.94	10.94	4,567.45
13	Hartnett & O'Brien, Point Coupee, La	11.98	11.98	5,001.65
14	Edwin B. Helgason, Natchez, Miss	11	11	4,592.50

REMARKS.—Proposals marked thus *, are the lowest received and the bidders considered responsible are recommended for acceptance.

8 (1895).—*Abstract of proposals received in response to advertisement dated February 16, 894, opened this day by Capt. John Millis, Corps of Engineers, for the construction of evees in the fourth district, improving Mississippi River*—Continued.

Name and address of bidder.	Atchafalaya levee district—Anchorage.		
	Embankment, 52,700 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.
	Cents.	*Cents.*	
James M. Sullivan, Memphis, Tenn	14¾	14¾	$7,847.00
Hayes Bros., Bonnet Carre, La	* 10	* 10	5,320.00
John Scott & Sons, St. Louis, Mo	12.74	10	6,763.98
Homan & McFadden, Baton Rouge, La	13	10	6,901.00
W. J. Bentley & Co., New Orleans, La	12¾	12¾	6,783.00
The Eltringham Construction Co., Natchez, Miss	10.73	10	5,704.71
N. P. Phillips, Red Liver Landing, La	16	16	8,512.00
Donovan, Daley & Co., Baton Rouge, La	11.70	8	6,205.90
D B. Hearin & Co., Baton Rouge, La	10.73	10	5,704.71
Michael Hanick & Co., Baton Rouge, La	13	12	6,911.00
Manning & Gibson, Natchez, Miss	12.70	12.70	6,756.40
Hartnett & O'Brien, Point Coupee, La	12.74	12.74	6,777.68
Edwin B. Helgason, Natchez, Miss	10¼	10¼	5,453.00

REMARKS.—Proposals marked thus *, are the lowest received and the bidders considered responsible, re recommended for acceptance.

mount available	$136,750.30
mount covered by this abstract	16,552.95
Balance	120,197.35

SURVEYS, GAUGES, AND OBSERVATIONS.

The usual discharge measurements were made during the high water of 1893 at Carrollton, at Red River Landing, and at Simmesport on the Atchafalaya. Surveys to determine changes in the river bottom in the vicinity of Belmont and Sarpy crevasses and above College Point were completed and results submitted. Special surveys have also been made, in compliance with instructions of the Commission of August 5, 1893, in the vicinity of Kennerville and near the old Lake Borgne Canal.

There were no difficulties of navigation in the main river channel in this district during the low-water season, and no channel depths less than 10 feet were reported.

Money statement.

June 1, 1893, balance unexpended	$6,553.09
Allotment approved by Secretary of War, May 18, 1893	12,000.00
Total available	18,553.09
May 31, 1894, amount expended during fiscal year	7,722.29
June 1, 1894, balance available	10,830.80
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	12,000.00

COMMERCIAL STATISTICS.

Statement showing the approximate receipts and shipments of freight by river from June 1, 1893, to June 1, 1894.

[Compiled from information derived from the commercial exchange of the representative towns and the several business houses and landings where the steamboats receive and discharge cargoes, and from the records of the custom-house port of New Orleans, La.]

NATCHEZ, MISS.

Articles.	Quantity.	Tonnage.	Value
Receipts.			
Cotton.....bales..	15,430	3,086	$462 90
Cotton seed.....sacks..	36,000	1,800	21,6[illegible]
Coal.....bushels..	1,632,000	57,120	28[illegible]
Flour.....barrels..	32,700	3,270	9[illegible]
Corn.....sacks..	35,200	2,640	61,6[illegible]
Oats.....do....	73,000	6,570	182,5[illegible]
Lumber.....feet, B. M..	4,000,000	6,000	60,0[illegible]
Miscellaneous.....packages..	94,988	7,074	28[illegible]
Total.....	5,919,318	87,560	1,38[illegible]
Shipments.			
Cotton.....bales..	9,338	1,868	28[illegible]
Corn.....sacks..	60,370	4,528	18[illegible]
Cotton-seed meal.....do....	12,460	779	19,9[illegible]
Flour.....barrels..	12,650	1,265	37,9[illegible]
Lumber.....feet, B. M..	920,000	1,380	1[illegible]
Oats.....sacks..	92,300	8,307	23[illegible]
Miscellaneous.....packages..	1,433,750	58,206	1,62[illegible]
Total.....	2,540,868	76,333	1,71[illegible]

For comparison the statistics for 1892 and 1893 are also given.

NATCHEZ, MISS.

	1892.	1893.	189[illegible]
Number of steamboats in the trade	32	29	[illegible]
Number of times arrived	1,008	828	[illegible]
Number of times departed	1,008	828	[illegible]
Number of barges	49	45	[illegible]
Total cargo received.....tons..	123,830	123,784	[illegible]
Value of same	$1,988,169.30	$1,469,089.00	$1,38[illegible]
Total cargo shipped.....tons..	30,786	26,394	[illegible]
Value of same	$1,037,281.00	$1,168,271.00	$1,71[illegible]
Total cargo shipped and received.....tons..	154,616	150,178	16[illegible]
Value of same	$3,025,550.96	$2,637,360.00	$3,09[illegible]

VIDALIA, LA.

Articles.	Quantity.	Tonnage.	Value
Receipts and shipments.			
Cotton.....bales..	4,000	800	$120,00[illegible]
Cotton seed.....sacks..	41,000	2,050	24,60[illegible]
Corn.....do...	5,200	390	3,1[illegible]
Coal.....bushels..	26,000	910	3,25[illegible]
Flour.....barrels..	5,300	530	15,90[illegible]
Molasses.....do....	160	43	2,40[illegible]
Lumber.....feet, B. M..	155,000	232	2,32[illegible]
Oats.....sacks..	7,500	675	18,75[illegible]
Miscellaneous.....packages..	19,827	1,631	219,956 50
Sugar.....barrels..	320	52	4,80[illegible]
Total.....	264,307	7,318	421,08[illegible]

For comparison the statistics for 1892 and 1893 are also given.

PLATE VIII.

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Statement showing the approximate receipts and shipments of freight by river from June 1, 1893, to June 1, 1894—Continued.

BATON ROUGE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Cotton.....bales..	830	166	$[illegible]
Cotton seed.....sacks..	33,330	1,667	[illegible]
Corn.....do....	4,625	347	[illegible]
Coal.....bushels..	800,000	28,000	[illegible]
Flour.....barrels..	70,000	7,000	[illegible]
Molasses.....do....	1,360	408	[illegible]
Moss.....bales..	6,344	793	[illegible]
Oats.....sacks..	63,000	5,670	[illegible]
Rice.....barrels..	980	117	[illegible]
Sugar.....do....	4,360	708	[illegible]
Cotton ties.....bundles..	5,000	140	[illegible]
Miscellaneous.....packages..	274,926	13.153	[illegible]
Total.....	1,264,755	58,169	[illegible]
Shipments.			
Cotton.....bales..	11,000	2,200	[illegible]
Cotton-seed meal.....sacks..	15,700	785	[illegible]
Coal.....bushels..	700,000	24,500	[illegible]
Corn.....sacks..	160,000	12,000	[illegible]
Flour.....barrels..	30,000	3,000	[illegible]
Lumber.....feet, B. M..	2,000,000	3,000	[illegible]
Moss.....bales..	5,000	625	[illegible]
Molasses.....barrels..	4,200	1,260	[illegible]
Oats.....sacks..	60,000	5,400	[illegible]
Rice.....barrels..	1,000	120	[illegible]
Sugar.....do....	25,300	4,111	[illegible]
Cotton ties.....bundles..	1,260	35	[illegible]
Miscellaneous.....packages..	1,313,447	11,962	[illegible]
Total.....	4,326,707	88,998	[illegible]

For comparison the statistics for 1892 and 1893 are also given.

	1892.	1893.	[illegible]
Number of steamboats in the trade	37	32	[illegible]
Number of times arrived	732	980	[illegible]
Number of times departed	552	980	[illegible]
Number of barges	146	165	[illegible]
Total cargo received.....tons..	346,068	98,614	[illegible]
Value of same	$3,280,558.00	$1,973,052.00	[illegible]
Total cargo shipped.....tons.	65,684	140,522	[illegible]
Value of same	$1,252,394.00	$2,111,542.00	[illegible]
Total cargo received and shipped.....tons..	411,932	239,135	[illegible]
Value of same	$4,532,952.00	$4,084,594.00	[illegible]

PLAQUEMINE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Corn.....sacks..	9,800	735	[illegible]
Cotton-seed meal.....do....	5,080	254	[illegible]
Coal.....bushels..	260,000	9,100	[illegible]
Flour.....barrels.	12,000	1,200	[illegible]
Molasses.....do....	420	126	[illegible]
Moss.....bales..	20	2	[illegible]
Oats.....sacks..	6,000	540	[illegible]
Rice.....barrels..	1,060	127	[illegible]
Sugar.....do....	2,200	357	[illegible]
Miscellaneous.....packages..	97,865	5,460	[illegible]
Total.....	294,445	17,901	[illegible]
Shipments.			
Coal.....bushels..	360,000	30,100	[illegible]
Corn.....sacks..	2,170	162	[illegible]
Lumber.....feet, B. M..	3,631,834	5,448	[illegible]
Molasses.....barrels..	5,000	1,500	[illegible]
Moss.....bales..	1,620	202	[illegible]
Oats.....sacks..	4,000	360	[illegible]
Rice.....barrels..	720	86	[illegible]
Sugar.....do....	988	161	[illegible]
Flour.....do....	5,330	533	[illegible]
Miscellaneous.....packages..	157,179	7,045	[illegible]
Total.....	5,278,821	45,597	[illegible]

For comparison the statistics for 1892 and 1893 are also given.

Statement showing the approximate receipts and shipments of freight by river from June 1, 1893, to June 1, 1894—Continued.

PLAQUEMINE, LA.—Continued.

	1892.	1893.	1894.
Number of steamboats in the trade	50	39	25
Number of times arrived	428	560	290
Number of times departed	402	560	290
Number of barges	66	30	34
Total cargo received.....tons..	82,214	24,137	17,901
Value of same	$1,023,243.00	$595,423.00	$732,141.50
Total cargo shipped.....tons..	45,234	62,393	45,597
Value of same	$833,479.00	$1,254,614.00	$469,024.50
Total cargo received and shipped.....tons..	127,488	86,530	63,498
Value of same	$1,850,722.00	$1,860,037.00	$1,201,166.00

DONALDSONVILLE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Corn.....sacks..	5,000	375	$8,750.00
Coal.....bushels..	3,000,000	105,000	375,000.00
Flour.....barrels..	850	85	2,550.00
Lumber.....feet, B. M..	3,500	5	52.50
Molasses.....barrels..	5	1	75.00
Oats.....sacks..	7,000	630	17,500.00
Rice.....barrels..	920	110	7,360.00
Sugar.....do....	250	40	3,750.00
Miscellaneous.....packages..	13,250	881	96,736.00
Total.....	3,030,775	107,127	511,773.50
Shipments.			
Coal.....bushels..	2,800,000	98,000	350,000.00
Molasses.....barrels..	54,000	16,200	810,000.00
Sugar.....do....	200,000	32,500	3,000,000.00
Rice (rough).....sacks..	45,000	4,500	112,500.00
Miscellaneous.....packages..	15,050	953	15,784.50
Total.....	3,114,050	152,153	4,288,284.50

For comparison the statistics for 1892 and 1893 are also given.

	1892.	1893.	1894.
Number of steamboats in the trade	36	42	29
Number of times arrived	884	835	575
Number of times departed	378	402	575
Number of barges	132	121	80
Total cargo received.....tons..	158,296	122,805	107,127
Value of same	$1,829,128.00	$604,589.00	$511,773.50
Total cargo shipped.....tons..	113,205	174,652	152,153
Value of same	$2,201,460.00	$4,008,782.00	$4,288,284.50
Total cargo received and shipped.....tons..	271,501	296,457	259,280
Value of same	$4,030,588.00	$4,613,331.00	$4,800,058.00

The above towns are, strictly speaking, "way points" and not termini, and the net tonnage or carrying capacity of the steamboats that do business at these places is not given.

All New Orleans steamboats are counted "arrived" when they stop on their journey up river and "departed" when they stop on their way down to New Orleans.

The St. Louis and Ohio River steamboats are counted "arrived" when they stop on their journey down the river and "departed" when they stop on their journey upstream.

Statement showing amount and value of commerce passing out of Red River and tributaries through Old River into the Mississippi River.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans, La.]

OLD RIVER.

Articles.	Quantity.	Tonnage.	Value.
Cotton.....bales..	100,886	20,177	$3,925,5[illegible]
Cotton seed.....sacks..	492,018	24,601	2[illegible]
Cotton-seed meal.....do....	136,866	8,554	171,[illegible]
Cotton-seed oil.....barrels..	3,176	635	47,[illegible]
Lumber.....feet, B. M..	4,642,000	6,963	69,[illegible]
Molasses.....barrels..	3,760	1,128	56,4[illegible]
Moss.....bales..	1,544	193	15,4[illegible]
Rice.....sacks..	10,564	1,056	2[illegible]
Sugar.....barrels..	9,838	1,599	11[illegible]
Sugar.....hogsheads..	1,805	1,173	7[illegible]
Staves (oak).....M..	862	3,103	17[illegible]
Miscellaneous.....packages..	18,671	4,974	11[illegible]
Total.....	5,421,990	74,126	4,1[illegible]

	1892.	1893.	189[illegible]
Number of steamboats in trade.....	24	17	[illegible]
Trips made by them.....	279	242	[illegible]
Net tonnage of same.....	9,043	73,571	6,[illegible]
Number of barges.....	8	19	[illegible]
Net tonnage of same.....	7,600	18,050	6,[illegible]
Total tonnage of steamboats and barges.....	98,643	91,621	7[illegible]
Total cargo brought.....tons..	90,866	53,858	[illegible]
Value of same.....	$9,458,901	$4,168,847	$4,15[illegible]

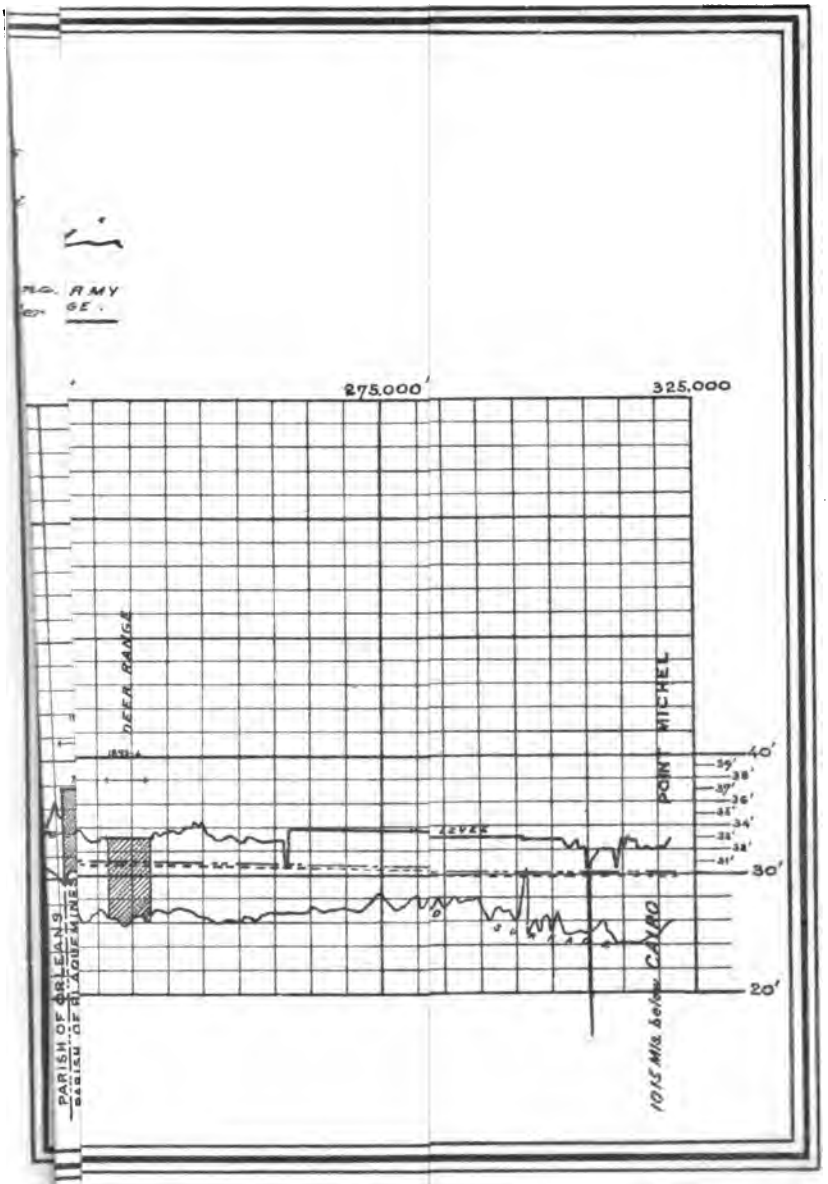
NOTE.—This does not include the upstream freight, which must be nearly equal to the downstream in value.

Statement showing the receipts by river at New Orleans, La.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans, La.]

Articles.	Quantity.	Tonnage.	Value.
Above the city.			
Coal.....bushels..	10,279,000	359,765	$1,2[illegible]
Cotton seed.....sacks..	950,408	47,521	5[illegible]
Cotton.....bales..	189,262	37,852	5,6[illegible]
Cotton-seed meal.....sacks..	191,864	11,991	2[illegible]
Cotton-seed oil.....barrels..	5,068	1,013	7[illegible]
Flour.....do....	187,809	18,781	5[illegible]
Flour.....half barrels..	42,032	2,102	6[illegible]
Corn.....bushels..	4,648,545	128,199	2,3[illegible]
Oats.....do....	770,744	12,332	2[illegible]
Cotton ties.....bundles..	19,274	540	[illegible]
Lumber.....feet, B. M..	27,643,705	41,465	2[illegible]
Molasses.....barrels..	174,347	43,775	2,6[illegible]
Moss.....bales..	5,518	590	6[illegible]
Rice.....barrels..	148	18	[illegible]
Rice.....sacks..	127,360	17,735	4[illegible]
Sugar.....hogsheads..	47,121	30,628	1,6[illegible]
Sugar.....barrels..	522,846	84,963	7[illegible]
Staves.....	2,272,350	9,293	[illegible]
Wheat.....bushels..	3,688,674	110,660	3,6[illegible]
Miscellaneous.....packages..	802,291	53,316	2,[illegible]
Total.....		1,013,543	30,4[illegible]
Below the city.			
Molasses.....barrels..	2,605	651	[illegible]
Moss.....bales..	114	11	[illegible]
Rice, clean.....barrels..	10	1	[illegible]
Rice, rough.....sacks..	19,443	1,944	[illegible]
Sugar.....barrels..	24,768	4,026	[illegible]
Miscellaneous.....packages..	375,818	41,825	[illegible]
Total.....		17,458	1,4[illegible]

PLATE X.



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Foreign commerce, port of New Orleans—Continued.

EXPORTS AND IMPORTS.

	1892.	1893.	
Total value of exports of foreign merchandise to foreign countries	$1,911,081.00	$478,993.00	
Total value of exports of domestic merchandise to foreign countries	130,183,916.00	81,812,507.00	
Grand total of exports foreign and domestic merchandise to foreign countries	132,094,997.00	82,291,500.00	
Total value of imports from foreign countries:			
Free	14,878,800.00	22,907,192.00	
Dutiable	5,442,415.00	3,912,923.00	
Specie	305,402.00	596,458.00	
Grand total	20,626,617.00	27,416,573.00	
Total duties collected	1,593,070.59	1,509,309.12	

Approximate value of plant belonging to the United States and used upon the impr of the Mississippi River, fourth district, May 31, 1894.

Class of property.	Value.	Class of property.	
Steamer General Newton	$8,000	Launch Lotur	
Steam launch Ruby	4,000	One warehouse barge	
Steam tug General Comstock	7,000	One warehouse barge	
Steam tug Tilda	6,000	Fifteen rowboats	
Steam launch Alaska	3,500	Tools and appliances	
Steam launch No. 5	2,000	Office furniture	
One dredge boat	6,000	Surveying instruments	
Four dump scows	4,000	Drawing instruments	
Five quarter boats	12,000	Railway cars and tracks	
Thirty barges	58,734		
Dredge	70,000	Total	

List of civilian engineers on work of river and harbor improvements in charge of John Millis, Corps of Engineers, to May 31, 1894, inclusive.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which emp
	Mos.			
H. S. Douglas, Natchez, Miss.	12	$200	Natchez, Miss	Levees, Lower Tensa district and gauge
W. J. Hardee, Baton Rouge, La.	12	200	Baton Rouge, La.	Levees, Atchafalaya fourche, and Pon train levee districts.
William Garvin, New Orleans, La.	12	175	New Orleans and Old River.	Improving Atchafa Red Rivers, and w gauges, and observa
E. B. Geddes, Natchez, Miss	11	140	Natchez, Miss	Levees, Lower Tensa district.
A. F. Woolley, jr., New Orleans, La.	11	140	New Orleans, La.	Surveys, gauges, and vations.
John Smyth, jr., New Orleans, La.	11	140	do	Levees, Lake Borgne a Barataria levee distric

The following maps and drawings accompany and form a part of my annual repor viz:

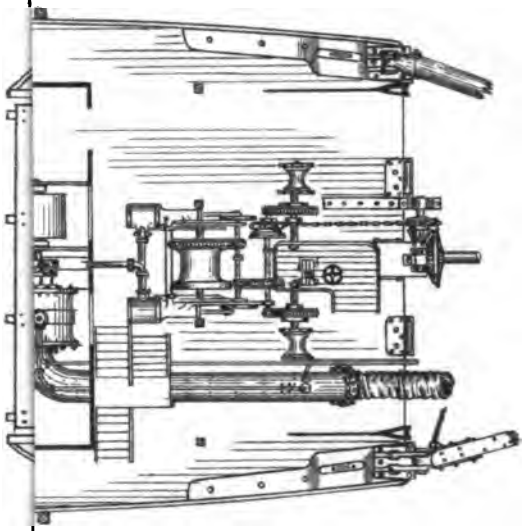
PLATES I, and II, III.—Dredge ram.
PLATE IV.—Lower Tensas and Big Black levee districts.
PLATE V.—Atchafalaya, Lafourche, and Pontchartrain levee districts.
PLATE VI.—Barataria and Lake Borgne levee districts.
PLATE VII.—Profile Lower Tensas levee district.
PLATE VIII.—Profile Atchafalaya levee district.
PLATE IX.—Profile Lafourche levee district.
PLATE X.—Profile Barataria levee district.
PLATE XI.—Profile Pontchartrain levee district.
PLATE XII.—Profile Lake Borgne levee district.
PLATE XIII.—Area of overflow, flood of 1893.

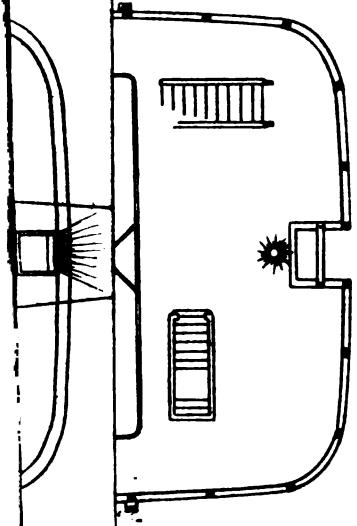
Very respectfully, your obedient servant,

JOHN MILLIS.
Captain of Engineers.

Col. C. B. COMSTOCK,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

PLATE I.





Drawn by N.A. Moram.

Eng 53 3

Statement showing amount and value of commerce passing out of Red River and tributaries through Old River into the Mississippi River.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans, La.]

OLD RIVER.

Articles.	Quantity.	Tonnage.	Value
Cotton ..... bales..	100,886	20,177	$3,03[illegible]
Cotton seed ..... sacks..	492,018	24,601	[illegible]
Cotton-seed meal ..... do....	136,866	8,554	1[illegible]
Cotton-seed oil ..... barrels..	3,176	635	[illegible]
Lumber ..... feet, B. M..	4,642,000	6,963	[illegible]
Molasses ..... barrels..	3,760	1,128	[illegible]
Moss ..... bales..	1,544	193	[illegible]
Rice ..... sacks..	10,564	1,056	[illegible]
Sugar ..... barrels..	9,838	1,599	[illegible]
Sugar ..... hogsheads..	1,805	1,173	[illegible]
Staves (oak) ..... M..	862	3,103	[illegible]
Miscellaneous ..... packages..	18,671	4,974	[illegible]
Total	5,421,990	74,126	4,15[illegible]

	1892.	1893.	1894
Number of steamboats in trade	24	17	[illegible]
Trips made by them	279	242	[illegible]
Net tonnage of same	9,043	73,571	[illegible]
Number of barges	8	19	[illegible]
Net tonnage of same	7,600	18,050	[illegible]
Total tonnage of steamboats and barges	96,643	91,621	[illegible]
Total cargo brought ..... tons..	90,866	53,858	[illegible]
Value of same	$9,458,901	$4,168,847	$4,12[illegible]

NOTE.—This does not include the upstream freight, which must be nearly equal to the downstream in value.

Statement showing the receipts by river at New Orleans, La.

[Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans, La.]

Articles.	Quantity.	Tonnage.	Value
Above the city.			
Coal ..... bushels..	10,279,000	359,765	$1,[illegible]
Cotton seed ..... sacks..	950,408	47,521	[illegible]
Cotton ..... bales..	189,262	37,852	5,67[illegible]
Cotton-seed meal ..... sacks..	191,864	11,991	[illegible]
Cotton-seed oil ..... barrels..	5,068	1,013	[illegible]
Flour ..... do....	187,809	18,781	[illegible]
Flour ..... half barrels..	42,032	2,102	[illegible]
Corn ..... bushels..	4,648,545	128,199	2,3[illegible]
Oats ..... do....	770,744	12,332	[illegible]
Cotton ties ..... bundles..	19,274	540	[illegible]
Lumber ..... feet, B. M..	27,643,705	41,465	[illegible]
Molasses ..... barrels..	174,347	43,775	2,61[illegible]
Moss ..... bales..	5,518	590	[illegible]
Rice ..... barrels..	148	18	[illegible]
Rice ..... sacks..	127,360	17,735	[illegible]
Sugar ..... hogsheads..	47,121	30,628	1,88[illegible]
Sugar ..... barrels..	522,846	84,963	[illegible]
Staves	2,272,350	9,293	[illegible]
Wheat ..... bushels..	3,688,674	110,660	3,68[illegible]
Miscellaneous ..... packages..	862,291	53,316	2,3[illegible]
Total	.....	1,013,543	30,48[illegible]
Below the city.			
Molasses ..... barrels..	2,605	651	[illegible]
Moss ..... bales..	114	11	[illegible]
Rice, clean ..... barrels..	10	1	[illegible]
Rice, rough ..... sacks..	19,443	1,944	[illegible]
Sugar ..... barrels..	24,768	4,626	[illegible]
Miscellaneous ..... packages..	375,818	41,825	[illegible]
Total	.....	17,458	1,41[illegible]

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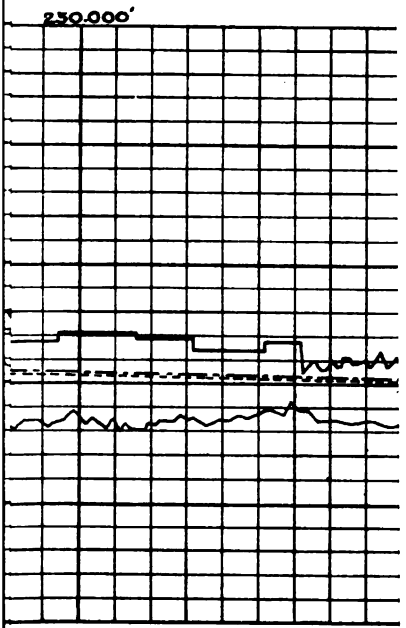
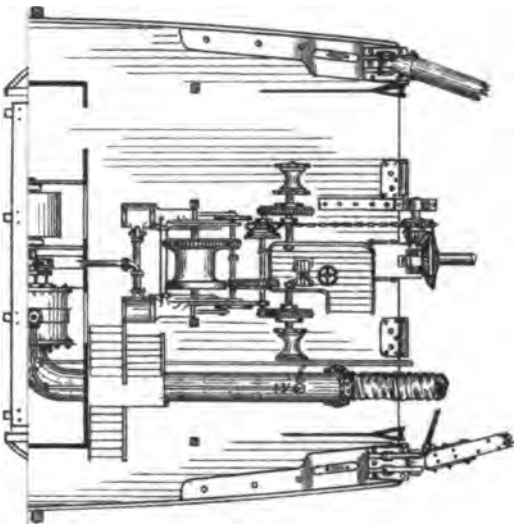
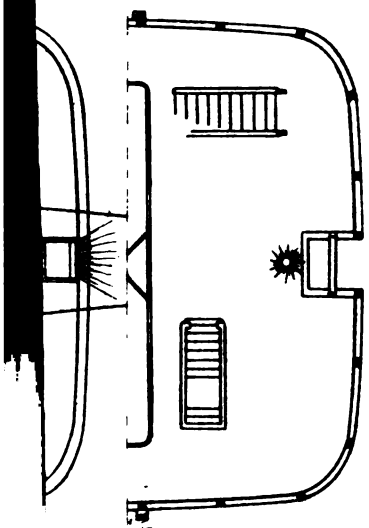


PLATE I.





Drawn by N.A. Morano.

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APPENDIX 4 A.

REPORT OF CAPT. JOHN MILLIS ON SURVEYS IN VICINITY OF CREVASSES.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 22, 1894

SIR: I have the honor to submit the following report upon certain surveys a observations relating to changes in the section of the river in the vicinity of c vasses and elsewhere in this district. Surveys were made under direction of t office during 1892-'93, in the vicinity of the Belmont and Prospect crevasses a near College Point. These surveys were made by Assistant Engineer Woolley. H reports as follows concerning the methods used in the work:

BELMONT AND PROSPECT CREVASSES.

(*1*) *Plan of surveys.*—At each of the crevasses I established thirteen sections, a designated them by letters A to M, inclusive. Each section was marked on t ground by six large stakes or hubs, being three on each bank; thus, one to the l side of the road, one in the land edge of the crown of the levee, and one on batture.

The zero of each section was assumed to be the land edge of the crown of levee on the same bank on which the crevasse is located. All sections w located normal to the river as nearly as practicable, and a traverse line was ru connect zeros.

The sections are located in alphabetical order, beginning with section A, at a p about 1¼ miles above the crevasse, and ending with section M, at a point about miles below the crevasse.

A section (F) was established opposite the center of the crevasse, sections E an being opposite the upper and lower ends of the crevasse respectively.

The distance between adjacent sections varies from 700 or 800 feet, in the im diate vicinity of the crevasse, to 4,000 feet for sections most remote from the crev The distance between the extreme upper section and the extreme lower sectio about 4¼ miles.

(*2*) *Soundings.*—Five sets of soundings were taken on these sections at var different stages of the river, ranging from low water to extreme high water and ba

gain to low water, and covering a period of about eleven months, from November, 892, to October, 1893.

The soundings were taken in the following manner: Large range signals were laced on both banks of a section so they could be clearly seen from any point of the ection, then a boat with leadsman and flagman on deck was run a short distance bove the section and drifted or backed down across the section, the sounding being aken as the leadsman passed in range with signals on shore.

When the boat ran above the section the lead was cast overboard at a sufficient listance above the section, then the lead was lifted often enough to keep it directly nder the boat and thus insure a vertical position of the lead line at the instant the ange line was passed.

A flagman was stationed on deck near the leadsman to assist in watching the range ine, to record soundings, and to signal to the transitman the instant the leadsman assed in line with the range signals. The steam tug *General Comstock* was used in aking the greater portion of these soundings. The steamer *Ruby* was also used on portion of this work, but could only be used to advantage during low stages of the vater and calm weather.

(*3*) *Datum plane.*—The soundings at the Belmont crevasse were reduced to the zero f the College Point gauge, or 21.24 Cairo datum. At Prospect crevasse the soundngs were reduced to 24.6, Cairo datum, which is a little above the annual low water.

All soundings were reduced by means of lead-line tests and gauge readings to show he exact depth of the water below the datum plane.

The lead line was tested frequently, being corrected and re-marked when it had ecome badly stretched. A temporary gauge was established and levels run to conect it with a permanent bench mark of known elevation.

Gauge was read morning, noon, and evening, and interpolations were made for ntermediate readings when the stage of the water was affected materially by wind r tide.

(*4*) *Location of soundings.*—All soundings were located by intersection, the angle f the intersection being measured by a transit instrument on shore. When the ead was cast overboard the flagman raised the flag to warn the transitman, who hen placed the vertical wire of the telescope on the leadsman (or lead line when ear enough to be seen), moving the telescope just fast enough to keep the leadsman n this position, and as the range line was passed the flagman quickly lowered the lag and the angle to the leadsman was recorded at the transit on shore.

The base line on which the transit stations were located vary from one-half to hree-fourths of the length of the sections. The exact location of each sounding was omputed and platted by the distance from the zero of the section.

(*5*) *Areas of sections.*—The areas of section were computed from datum planes mentioned above and were obtained by the distance between adjacent soundings multiplied by the mean of the two adjacent soundings.

The cross sections were platted as a check against such errors in soundings as night occur in reading the lead line owing to eddy water and wind drifting boat out f its proper course.

(*6*) *College Point sections.*—Two sections were laid off at a point about midway of he straight reach above College Point. These sections were located about one-half mile apart and about 6 miles above Belmont crevasse, and were to determine the hanges, if any, which take place in the bottom of the river at a point removed from he immediate influence of the crevasse.

The datum plane used was the zero of the College Point gauge, and the same general lans and methods as used at Belmont and Prospect were followed throughout.

The areas of all these sections were afterwards corrected to obtain the area of section below a horizontal line at grade of top of levee. These corrected areas were the nes used in this report.

In connection with the results of these surveys it will be interesting to examine nd compare others of a similar nature previously made in this district at the Bougere, Morganza, Nita, and Bonnet Carre crevasses. The areas of the different sections ounded at these latter points have therefore been carefully computed also from otes and drawings on file in this office, and these are given, together with the secions found by the recent surveys, in the accompanying tables.

It will be seen that the results show such irregular variations that it seems hardly ossible to arrive at any general conclusions of value by considering the areas of individual sections, and the mean of the areas of different sections have therefore been omputed, and the results shown graphically on the accompanying diagrams.

Throughout the portion of the river which includes the location of all of these oundings there is no considerable variation in width between bank lines or length f section, except perhaps a slow general increase in width which would not materially affect the results of observations confined to a comparatively limited period of time, and it can therefore be assumed that the oscillations and changes in area of ections which occur in one year are attributable almost entirely to changes in the river bottom or variations in depth below a fixed datum.

Each locality will first be considered separately.

NITA, 900.5 MILES BELOW CAIRO.

This was a very large crevasse which occurred on March 14 during the great fl of 1890. The break was on the east bank near the middle of a bend convex tow the east. The estimated maximum discharge was about 400,000 cubic feet per s ond, which greatly exceeds the estimated discharge of any other crevasse in t district of which there is any record. The land along the river in the vicinity w cleared and under cultivation back to the swamp, an average depth of about miles.

There had been no previous crevasse near enough or recent enough to be con ered as having any effect within the limits of the soundings. Two sets of sound were made, one in September following the break, College Point gauge, 4½ m below the center of the break, reading 2.35 to 2.70 feet; and one in June follow after the flood of 1891, College Point gauge reading 8.38 to 11.72 feet. The l was rebuilt around the crevasse during the low water of 1890 and no other br occurred during the flood of 1891 nearer than the Ames crevasse, 58 miles below

Eighteen sections were sounded at various intervals, extending from about 4½ m above the center of the break to about 5 miles below. The areas computed from second soundings all show an increase over those obtained from the first, excep the extreme upper section A, section F, and on the extreme lower section R. these three there was a decrease. The changes vary between a 3 per cent decr on section R and a 29 per cent increase on section K. The two upper sections a and above a reverse bend above the break, while the lower ones are in the stra reach extending down to College Point.

To make a comparison, therefore, of the changes of area above the break with changes below without introducing what might be considered as other condit likely to affect the result, the means of sections C to I inclusive and of sections P inclusive are shown on the diagram. They show an increase in mean area about 6 per cent above and of about 14 per cent below.

BELMONT, 807 MILES BELOW CAIRO.

This crevasse occurred on June 12 during the flood of 1892. It was also on east bank and about the middle of a bend convex toward the east. Its estim maximum discharge was about 140,000 cubic feet per second. It was 6½ miles b the Nita break, the only other crevasse that could be at all considered as ha any probable effect at Belmont; and since Nita occurred two years previous, wi large flood each intervening season, there seems to be hardly any probability i its influence could affect the results of the soundings at Belmont. The country this vicinity was cleared and cultivated as at Nita.

Thirteen sections were sounded here and four sets taken on each section in J ary, March, July, and September following the date of the break. The break closed during the low-water season following its occurrence and during the flo 1893 the nearest crevasse that remained open was Rescue, 34 miles above.

For reasons similar to those already stated comparison of changes in area a and below the break are made by taking the mean of sections A to F inclusive F to K inclusive. These show a final increase in mean area between the first last set of 1 per cent above and an increase of 2 per cent below the break, bu intervening variations are large and quite irregular.

PROSPECT, 935 MILES BELOW CAIRO.

This also broke during the flood of 1892 on June 13, and was on the east near the upper end of a short straight reach between two bends curving in opp directions. The strip of cultivated land along the river at this point is nar than at Nita or Belmont, averaging from 1 to 1½ miles wide.

A comparatively unimportant break took place the same year at Ancho miles above, which remained open during the flood. Thirteen sections were sou at Prospect at five different periods—in December, January, March, July, and tember-October, following the crevasse. The opening was closed during the water season following this break and no crevasse occurred near during the fol ing flood.

For comparison of changes in areas the mean of areas on sections B to F i sive and on sections F to I inclusive are shown on the diagrams. There was a decrease in area between first and last set of soundings of 9 per cent above the b and a decrease below of 4 per cent, the variations being quite different from t observed at Belmont. The lower sections of this survey cover the deepest pla the Mississippi River.

COLLEGE POINT, 901 MILES BELOW CAIRO.

The two sections sounded here are identical with sections O and P sounded in Nita crevasse survey. They are in a comparatively straight reach of the ri miles above the Belmont crevasse and separated from it by the most acute ben

the lower river. It therefore seems a fair assumption that the changes in the river bottom here shown by the last survey can in no way be attributable to the effects of a crevasse. The results of the soundings in 1890, 1891 and 1893 are both shown for comparison. The changes shown during the last survey are similar to those observed at Belmont, except that there is a final decrease of area of section and the intermediate variations are somewhat more marked.

At all of the above-named points the levee system has been generally maintained for a great many years on both banks of the river.

MORGANZA, 789 MILES BELOW CAIRO.

This point is on the west bank of the river near the lower portion of a very nearly semicircular bend of two miles radius which is convex toward the west. A number of crevasses have taken place here, and the breaks have remained open at different times for considerable periods. The country in the immediate vicinity is now wooded and covered with a considerable undergrowth, while the sand deposits have left the surface very irregular, the original ground surface being gullied out and washed away in some places, and covered with ridges and mounds of sand and mud in others. This condition of the surface has existed for a long time. Detached pieces of private levees have been built at different places on the east bank, but overflow of the east bank during any considerable flood has been effectually limited only by the bluff line at this point, which is about 10 miles distant.

There have been a number of breaks at this place, and their history is briefly summarized as follows:

Dates of crevasses at or near Morganza.	Date closed.	Remarks.
1828	(?)	The history previous to the crevasse of 1874 seems to be somewhat uncertain.
1844	(?)	
1850	1865	
(?)	1866	
1871	(?)	
Apr. 16, 1874	Feb., 1884	
Mar. 14, 1884	Jan., 1887	
Apr. 22, 1890	Mar., 1891	

It thus appears that this crevasse has been open during all the great floods, at least from that of 1874 up to include that of 1890, and has remained closed since that date, the levee having held during the floods of 1891, 1892, and 1893.

The maximum discharge in 1884 was estimated at 200,000 cubic feet per second, and 1890 at about 147,000 cubic feet per second.

Several sets of soundings have been taken in this locality at different times. These have been reduced to common datum lines and areas of section computed, as far as practicable, from the record. The results are given in tabular form.

The records show satisfactorily that the different sets of soundings were taken on the same sections as the table indicates.

BONNET CARRE, 929 MILES BELOW CAIRO.

This is on the east bank, just below an abrupt bend convex to the eastward, and at a point where the river approaches to within about 6 miles of Lake Pontchartrain.

So far as can be ascertained the breaks here have been as follows:

Date of crevasses at Bonnet Carre.	Date closed.
Dec. 19, 1849	1850
Apr. 20, 1859	1859
Apr. 20, 1871	1872
Apr. 11, 1874	Feb., 1883

The crevasse has remained closed since 1883. During the flood of 1892 a comparatively unimportant break took place about a mile below the Bonnet Carre crevasse, which is known as the Anchor crevasse. This was closed the next low-water season and no crevasse in the immediate vicinity has occurred since. The last soundings taken were made in 1882.

The country in the rear of Bonnet Carre resembles that back of Morganza, being very uneven from the effect of scour and deposits, and generally covered with timber and undergrowth. During the last few years, however, considerable clearings have been made and many of the ridges and the higher lands are now under cultivation in small detached areas.

The estimated maximum discharge through this crevasse of 1850 was 114,000 cubic feet per second. The maximum width of the crevasse of 1850 is given as 5,300 feet, and that of 1874 as 1,370 feet. Several sets of soundings at this place are on record. They are confined to five different sections and cover a considerably less extent of the river than the other surveys previously referred to. Some of the surveys are incomplete.

BOUGERE, 740 MILES BELOW CAIRO.

This point is about 6 miles below the present terminus of the levee system of the Lower Tensas levee district. It is in a bend convex to the westward, and no complete levee has ever been maintained on the opposite bank. Though the existing levee proper now terminates above, high ridges and the low private levees which still remain form a fairly effective barrier against overflow, except in extreme high water, extending from the lower terminus of the levee system down to Bougere Landing at the upper end of the crevasse, and from the lower end of the crevasse down almost 10 miles below.

The levee was maintained around this bend up to about 1873, when it was destroyed by the caving of the bank, and the levee has never been restored since. The break has enlarged by continual caving of the bank and also probably by washing away of the levee until the so-called crevasse is about 6 miles wide. During extreme floods the depth of water flowing through averages about 2.5 feet, though in places it is as much as 8 feet deep.

The country in the rear is entirely wild and grown up with trees and undergrowth. It has the usual rough surface produced by deposits and scour. The water flowing out through this opening goes directly toward Red River, here only 5 miles distant. The mouth of Red River is only 25 miles below.

During December, 1893, four sections were sounded in this bend in connection with survey made to locate a proposed levee for closing the break. The areas of these sections have been computed, and also those shown by the soundings taken during the Mississippi River Commission survey, in the latter part of December, 1882. This break is unlike the others considered, in that the flow of water through it is sometimes reversed. When the Red is higher than the Mississippi River the flow is toward the latter, but the conditions are such that the overflow toward the Red is by far the most important in its effects and of the most prolonged and frequent occurrence. A deposit of sand has taken place in the river bed opposite this break which is quite remarkable for that part of the river, and the width between bank lines at extreme low water is only 1,500 feet in the narrowest part. The low-water section is only about 57,200 square feet. No regular river gauge is maintained near to Bougere than Red River Landing. Mr. Jackson, who has lived at Jackson Point opposite and a little above Bougere, since 1853, recently informed me that the flood of 1882 was the highest he had ever seen at Jackson Point, and that of 1890 was the next highest. He had made high-water marks for both these floods, and by level it was found that the flood of 1882 was 1.28 feet higher than that of 1890.

Of the other openings in the main levee system of this district, that at Red River Landing, through Old River, connecting with the Red and Atchafalaya, has peculiar features, and it hardly comes within the scope of this paper.

BAYOU MANCHAC.

This bayou, which has its origin on the left bank, 848 miles below Cairo, was an insignificant outlet, and it has been closed by the levee at its head almost ever since a levee system was attempted in this locality.

BAYOU PLAQUEMINE, 854 MILES BELOW CAIRO—RIGHT BANK.

This was closed about 1865–1868, and has remained closed ever since. There has been no recent soundings in this vicinity available for comparison. The closure of the opening does not seem to have had any material effect on the flood level of the river so far as can now be ascertained.

BAYOU LAFOURCHE, 886 MILES BELOW CAIRO—RIGHT BANK.

This stream has at its head a high-water width of about 250 feet, or one-twelfth the high-water width of the main river at that point. The oscillation of the surface between high and low water there is about 30.6 feet, and at low water there is a sufficient depth in the head of the bayou for even the lighest draft boats without dredging. No recent soundings have been taken here to my knowledge, except those of the Mississippi River Commission survey, and the results of those soundings have not been received at this office. The gauge readings during recent floods show that this outlet bayou has had no material effect in restricting the flood height of the river at this point. The latest measured discharge was that of February 21, 1893, and this discharge was then 31,963 cubic feet per second, river at bank-full stage.

At the Jump and Cubitt crevasse, near the Head of the Passes, no recent surveys have been made under direction of this office, and these openings are too far below the terminus of the levee system to be of interest in connection with the present discussion of the subject.

Of the crevasses or breaks discussed in this paper, that at Bougere is of interest as being an example of a very long shallow opening whose bottom corresponds approximately in grade to the bank-full stage of the river at that point, and which remains open for all stages above the level of its bottom or "sill."

Both the sand-bar formation and the caving of the bank at this locality are very marked for the portion of the river between Natchez and the mouth of Red River. The deposit of sand can probably be attributed directly to the overflow during high water, and the caving is no doubt aggravated by the contracted low-water channel and the consequent increase of current and erosion. No regular record of stages of the river has been kept in this vicinity, but so far as the information goes there does not seem to have been any marked effect on flood heights which can with certainty be attributed directly to the crevasse, though any effect which could otherwise be noticeable is no doubt modified by the proximity of the opening to the mouth of Red River.

Whether the effects on the low-water section and the erosion of the bank would be so marked in a portion of the river where the ratio of depth of opening to mean depth and the slope of the river are less, is questionable. It is more than probable that if the country in the rear of the crevasse were cleared and opened, instead of being thickly covered with trees and other vegetable growth, the effects on flood heights would be greater.

At Morganza the levee which was rebuilt in 1884 only held a month, so that for the purposes of this discussion the crevasse may be considered as open practically from and including the flood of 1874 up to early in 1887, and there was a diminution of area of section both above and below the break as shown by the surveys of 1883 and 1887, this diminution being more marked below the opening. By 1887 the areas above show no change, those below having increased somewhat. The surveys of 1883, 1887, and 1888, it will be noted, were all made about the same time of the year and just previous to the spring floods. The survey of 1889 was made in October, the latter part of the low-water season, and it shows marked decrease in areas both above and below in nearly the same ratio for both. The great crevasse of April, 1890, occurred during the succeeding flood; the levee was restored the following low-water season, held during the flood of 1891, and in June following, soon after the water had gone down, the survey of 1891 was made.

It shows a general increase in section areas, though the mean is just about equal to its least value previous to 1889. Between the date the levee was restored in 1887 and the survey of 1889 no very high water occurred, and the river did not rise above a bank full stage for more than short periods. The variations in areas of sections, found by the soundings of 1887, 1888, and 1889, can not therefore be attributed entirely or mainly to the effects of closing the break in 1887. Between the soundings of 1889 and 1891 occurred the great flood of 1890, during which the levee broke. The soundings of January, 1891, show a marked increase of area, with the river at a bank full stage and before the new levee was entirely completed.

The crevasse at Bonnet Carre broke in 1874 and was not closed till February, 1883, so it was open during the entire period covered by the surveys herein referred to. The serious floods during this time were those of 1874 and 1882. All of the soundings previous to 1880, including the incomplete ones of 1875, show an increase of sectional area which is not accounted for entirely by yearly oscillations.

The increase must be attributed, at least in part, to causes other than the opening of the levees, since the stages of the river were at no time high enough to bring into play the influence of either to any considerable extent. Between the low-water season of 1878 and the soundings of January, 1880, there was a marked increase, with no very high water intervening.

The annual oscillations observed at College Point, Belmont, and Sappy throw no satisfactory light on this result.

Between the soundings of 1880 and those of 1882 there was a decrease in area. These two sets of observations were made about the same time of the year, and the great flood of 1882 intervened, during which the crevasse remained open. There were a number of breaks that year, so that it is hardly practicable to deduce satisfactory conclusions as to the effect of the Bonnet Carre on the flood height. The close agreement between the changes above the break and those below will be observed.

The results at Nita indicate a marked enlargement of section between September, 1890, and June, 1891, and this has been interpreted as showing that the shoaling of the river was a direct effect of the crevasse. The assumption has been that a deposit took place at the time of the crevasse which remained until after the succeeding low water and was washed away by the following high water, during which the levees were maintained.

At Belmont and Prospect there is sufficient agreement as to general conditions width and depth of opening, etc., to give grounds for expecting a closer agreeme in changes in river section than the surveys disclose. The methods followed in t survey, the care with which the work was done, and the fact that the results each locality are consistent among themselves, render it highly improbable that t apparently abnormal results obtained at Prospect are due to error. The ra decrease in section after the survey of December, following the break and the v slight recovery during the great flood of 1893, may perhaps be due to some abnor conditions in this locality, such as the great depths below. Be this as it m these results do not appear to afford support to the theory of a deposit attributa to a crevasse, or its removal by a succeeding flood.

At Belmont and College Point the oscillations agree very closely, and indicate tha these localities at least the areas below a fixed datum undergo marked changes, wh are in some degree direct functions of the height of the river surface. While th changes may be and probably are to some extent affected by a crevasse in the v ity, they can by no means be attributed entirely to this cause.

The areas of sections P and O at Nita, survey of 1890 and 1891, are plotted on diagram of areas of the same sections as found in 1892 (College Point survey). I evident that the dates upon which the soundings of 1890 and 1891 were made m be considered in deducing conclusions from the results, and the same remarks ap to the soundings of 1889 and 1891 at Morganza.

The last soundings above College Point seem to warrant the inference that ha crevasse occurred at Morganza or Nita the surveys at these places would have sho changes precisely similar in direction, though perhaps less in degree.

I would draw the following general conclusions from the foregoing:

(1) That the bottom of the lower river undergoes what may be termed oscillatio or changes in elevation, which are not constant in rate or direction; that the per of these oscillations is comprised within one year, and that they seem to have n direct connection with the annual oscillations in height of the river surface, tho a general law can not be deduced from the data available.

(2) That such oscillations must have had a material effect on the results of s veys heretofore made to determine the effect of crevasses, and the conclusions dra from these surveys should in some cases be considerably modified.

(3) That a very long opening, with a sill or bottom at or near the grade of the of the bank, which remains constantly open, would be likely to cause a large dep in the river bed opposite and increased caving along the bank the opening is Whether such deposit and caving would become serious at locations where the d of the river is very much greater than at Bougere, or where the opening might h been the opposite side of a bend, may be open to question.

(4) A large break, like a crevasse which occurs at or near high water and a point where the ratio of depth of crevasse to depth of the river is as small a usually the case below Red River, can have at most only a temporary and comp atively slight detrimental effect of any kind on the main river channel. Moreo there appears to be no good ground for apprehending that such detrimental ef admitting that it exists at all, would be cumulative or would become serious ev the break should occur at or near the highest point of successive great floods.

Though not exactly within the scope of this paper as originally contemplate may be added that there is no satisfactory evidence to establish definitely what w be the effect on flood heights by an opening like that at Bougere, if one existed b the mouth of Red River.

As to comparatively narrow and deep openings, like the Lafourche and Plaquem there is nothing to show that they have had any appreciable effect on flood hei one way or the other, neither in restricting these heights when open, and increa them when closed, nor *vice versa*.

The curves of gauge readings show that a crevasse has invariably an immed and effective influence in restricting the height of the lower river.

That it is practicable to make any form of permanent opening which will res flood heights I believe to be a matter of serious doubt.

This subject has been frequently discussed heretofore, and conclusions have b arrived at which are more or less at variance. The present object is only to pre the new facts and to deduce the conclusions which the data now available s to warrant, regardless of whether these conclusions seem to confirm previo expressed views or otherwise.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Col. C. B. COMSTOCK,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

BOUGERE.

10 miles below Cairo, right bank. Crevasse broke 1873. Approximate greatest average depth of water in crevasse, 8 feet. Greatest width, 6 miles. Datum line for sections high water, 1882 (48.5), or Red River Landing gauge. Surveys by: 1882, Mississippi River Commission; 1893, H. S. Douglas.]

DECEMBER 18 TO 23, 1883.

[Datum plane equals high water of 1882. Red River Landing gauge reading, 48.50.]

Section.	Areas.	Means.	Mean depths.
	Sq. feet.	*Sq. feet.*	*Feet.*
	231, 500		48.7
	213, 900	203, 700	50.9
	170, 700		64.4
	198, 700		64.1

DECEMBER 6 TO 7, 1893.

	202, 350		42.1
	171, 810	185, 270	49.8
	184, 340		52.6
	182, 580		56.

MORGANZA.

80 miles below Cairo, right bank. Crevasse broke (last time) April 22, 1890. Levee rebuilt March, 1891. Approximate greatest average depth of water in crevasse, 15.7 feet. Greatest estimate discharge, 147,000 cubic feet per second. Datum line for sections 33.13, Cairo datum. Surveys by: 1883, Mississippi River Commission; 1887, W. J. Hardee; 1888 and 1889. John Ewens; 1891, W. J. Hardee.]

Section.	Location above or below center of break.	Date.	Areas.	Means.	Mean depths.
	Feet.		*Sq. feet.*	*Sq. feet.*	*Feet.*
	* 26, 900	Feb., 1883	112, 186		43.6
	* 22, 600	....do	114, 583		35.5
	* 17, 100	....do	118, 958		69.2
	* 12, 500	....do	110, 312		66.1
	* 7, 400	....do	129, 750	114, 450	55
	* 4, 700	....do	108, 599		42.6
	* 700	....do	104, 633		34
	† 700	....do	110, 970		37.9
	† 3, 800	....do	92, 183		37.3
	† 7, 100	....do	109, 869	107, 465	50.4
	† 9, 200	....do	96, 967		49
	† 13, 600	....do	127, 352		58.4
	† 16, 000	....do	131, 315		49
	† 20, 300	....do	121, 404		43.4
	† 23, 000	....do	102, 130		44.4

*Above. † Below.

Section.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
		Sq. feet.	*Sq. feet.*	*Feet.*		*Sq. feet.*	*Sq. feet.*	*Feet.*
	Jan. 14–25, 1887	113, 697		45.8	Jan. 25–31, 1888	110, 048		45.1
	....do	121, 899		37.2	....do	119, 845		34.6
	....do	99, 906		50.0	....do	101, 182		50.1
	....do	106, 841		62.8	....do	105, 719		57.8
	....do	109, 702	105, 114	47.7	....do	112, 743	104, 339	48.6
	....do	97, 277		40.0	....do	100, 284		43.4
	....do	101, 845		35.6	....do	101, 767		37.1
	....do	93, 003		33.1	....do	97, 226		37.1
	....do	89, 658		40.8	....do	94, 911		41.3
	....do	89, 193	90, 769	40.5	....do	92, 082	97, 874	43.8
	....do	81, 169		36.9	....do	93, 192		41.8
	....do	109, 733		48.8	....do	111, 957		50.4
	....do	115, 445	.....	39.0	....do	113, 966	.....	39.0
	....do	87, 925	.....	28.0	....do	97, 187	.....	31.0
	....do	85, 737	.....	35.7	....do	87, 355	.....	38.0

MORGANZA—Continued.

Section.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
		Sq. feet.	*Sq. feet.*	*Feet.*		*Sq. feet.*	*Sq. feet.*	*Feet.*
1	Oct. 14–19, 1889	90,524		38.5	Jan. 8–14, 1891	104,390		47
2	do	113,430		37.2	do	94,690		2
3	do	90,900		48.4	do	118,430		6
4	do	103,020		56.6	do	108,630		6
5	do	99,205	97,204	49.9	do	95,770	106,738	4
6	do	94,120		48.5	do	104,830		4
7	do	98,775		37.7	do	96,030		3
8	do	86,590		33.2	do	82,720		2
9	do	81,597		37.4	do	108,840		4
10	do	80,135	82,185	39.1	do	88,420	96,140	4
11	do	78,360		39.2	do	86,490		4
12	do	84,245		35.4	do	114,230		4
13	do	102,705		35.1	do	109,740		3
14	do	89,075		30.7	do	87,620		3
15	do	89,670		40.4	do	90,010		3

NITA.

[900.5 miles below Cairo. Crevasse broke March 14, 1890. Levee rebuilt February, 1891. Average height of levee above natural surface of ground, 11½ feet. Average depth of water in crevasse, feet. Greatest width, 3,105 feet. Number of days water ran through break, 122. Greatest estimated discharge, 400,000 cubic feet per second. Datum line for sections, 47.24, Cairo datum. Surveyed by W. J. Hardee, under direction of Capt. Kingman and Lieut. Millis.]

Section.	Location above or below center of break.	Date.	Areas.	Means.	Mean depths.
	Feet.		*Sq. feet.*	*Sq. feet.*	*Feet.*
A	*23,900	Sept. 15–19, 1890	188,021		5
B	*18,300	do	182,400		6
C	*12,600	do	179,100		7
D	*7,600	do	196,150		7
E	*4,100	do	213,934		8
F	*2,600	do	180,260	189,283	7
G	*1,500	do	179,620		7
H	*800	do	184,900		8
I	Center	do	191,032		9
J	†750	do	176,230		8
K	†1,500	do	160,730		5
L	†2,500	do	160,050		6
M	†3,800	do	161,200	169,299	6
N	†5,900	do	171,630		6
O	†8,800	do	169,385		6
P	†12,600	do	164,142		7
Q	†17,900	do	165,100		5
R	†24,400	do	204,020		8

* Above. † Below.

Section.	Date.	Areas.	Means.	Mean depths.	Remarks.
		Sq. Feet.	*Sq. Feet.*	*Feet.*	
A	June 16–21, 1891	185,554		67.5	
B	do	191,440		69.7	
C	do	189,845		79.1	
D	do	198,406		78.4	
E	do	216,100		81.3	
F	do	179,295	196,569	72.3	
G	do	192,650		78.6	
H	do	190,570		71.6	
I	do	200,120		99.6	
J	do	207,900		72.9	
K	do	194,465		72.0	
L	do	192,905		75.6	
M	do	184,960		70.1	
N	do	194,685	192,476	74.9	
O	do	185,050		74.3	Upper section Cross Point survey.
P	do	170,750		73.6	Lower section Cross Point survey.
Q	do	181,800		65.2	
R	do	197,000		51.2	

COLLEGE POINT.

miles below Cairo. Datum line for sections 47.24, Cairo datum. Survey in 1890-'91 by W. J. rdl e. under direction of Capt. Kingman and Lieut. Millis; survey in 1893 by A. F. Wolley, jr., ler direction of Capt. Millis.]

tion.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
		Sq. feet.	*Sq. feet.*	*Feet.*		*Sq. feet.*	*Sq. feet.*	*Feet.*
er	Sept. 15-19, 1890	169, 385	166, 763	68	June 16-21, 1891	185, 050	177, 900	74. 3
er	....do	164, 142		70. 8	....do	170, 750		73. 6
er	Jan. 19-17, 1893	191, 216	185, 806	77. 4	Mar. 22-22, 1893	192, 802	184, 857	78
er	....do	180. 397		78. 4	....do	176, 913		76. 9
er	July 18-17, 1893	200. 861	193, 427	81. 3	Sept. 20-20, 1893	189, 315	183, 045	76. 6
er	....do	185, 994		80. 8	....do	176, 775		76. 8

BELMONT.

miles below Cairo, left bank. Crevasso broke June 12, 1892. Levee rebuilt February, 1893. Aver- e height of levee above ground surface, 8 feet. Approximate greatest average depth of water in crevasse, 18 feet, greatest width, 1,427 feet. Number days water ran through break, 56. Greatest timated discharge, 140,000 cubic feet per second. Datum line for sections, high water, 47.24. Cairo tum. Survey by A. F. Woolley, jr., under the direction of Capt. Millis.]

ction.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
		Sq. ft.	*Sq. ft.*	*Feet.*		*Sq. ft.*	*Sq. ft.*	*Feet.*
.....	Jan. 5-11, 1893...	214, 646		51. 1	Mar. 15-21, 1893..	215, 883		51. 4
.....	....do	185. 659		50. 1	....do	190, 863		51. 6
.....	....do	191. 433	202, 339	50. 3	....do	192, 974	202, 036	50. 8
.....	....do	195, 047		51. 8	....do	195, 211		51. 9
.....	....do	201, 302		52. 3	....do	199, 907		51. 9
.....	....do	225, 947		53. 4	....do	217, 379		51. 4
.....	....do	187, 855		57. 4	....do	202, 128		61. 8
.....	....do	181. 824		52. 4	....do	188, 894		54. 4
.....	....do	192, 675	196, 479	53. 5	....do	179. 118	193, 934	49. 8
.....	....do	195, 610		53. 6	....do	186. 965		51. 2
.....	....do	194, 962		65	....do	189, 122		63
.....	....do	213, 183	.....	64. 6	....do	214, 734	.....	65. 1
.....	....do	201, 507	.....	77. 5	....do	200, 436	.....	77. 1
.....	July 19-24, 1893 .	217, 882		51. 8	Sept. 20-26, 1893 .	207, 988		49. 5
.....	....do	196, 696		53. 2	....do	192, 747		52. 1
.....	....do	206, 489		54. 3	....do	199. 128		52. 4
.....	....do	194, 425	209, 895	51. 7	....do	202. 100	207, 298	53. 7
.....	....do	212, 540		55. 2	....do	215, 063		55. 8
.....	....do	228, 338		54	....do	226, 762		53. 7
.....	....do	210, 545		64. 4	....do	207, 461		63. 4
.....	....do	203, 179		58. 5	....do	195, 803		56. 4
.....	....do	203, 643	203, 983	56. 6	....do	193, 662	200, 715	43. 8
.....	....do	186, 873		51. 2	....do	190, 907		52. 3
.....	....do	191. 319		63. 8	....do	189, 695		63. 2
.....	....do	217. 092	.....	65. 8	....do	219, 345	.....	66. 5
.....	....do	206, 289	.....	79. 3	....do	204, 710	.....	78. 7

PROSPECT.

5 miles below Cairo, left bank. Crevasse broke January 13, 1892. Levee rebuilt February, 1893. Average height of levee above natural ground surface, 8 feet. Approximate greatest average depth of water in crevasse, 17.5 feet; greatest width, 1,340 feet. Number of days water ran hrough break, 59. Greatest estimated discharge, 116,000 cubic feet per second. Datum line for ections, high water, 41.86, Cairo datum. Survey by A. F. Woolley, jr., under direction of Capt. Millis.]

Section.	Location above or below center of break.	Date.	Areas.	Means.	Mean depths.
	Feet.		*Sq. ft.*	*Sq. ft.*	*Feet.*
.....	*9, 100	Dec. 20-23. 1892..	186, 060	.....	74. 4
.....	*4, 600	....do	193, 038)		64. 3
.....	*2, 700	....do	200, 323		55
.....	*1, 330	....do	215, 065	205, 801	53. 3
.....	*530	....do	200. 484		51. 7
.....	Center.	....do	211, 099		45
.....	†550	....do	208, 974	209, 315	53. 3
.....	†1, 150	....do	200, 133		50
.....	†2, 340	....do	217, 054		55. 7
.....	†4, 350	....do	260, 739	.....	82. 8
.....	†6, 500	....do	423, 684	.....	114. 5
.....	†9, 800	....do	202, 813	.....	71. 7
.....	†13, 240	....do	206, 433	.....	70

*Above. †Below.

PROSPECT—Continued.

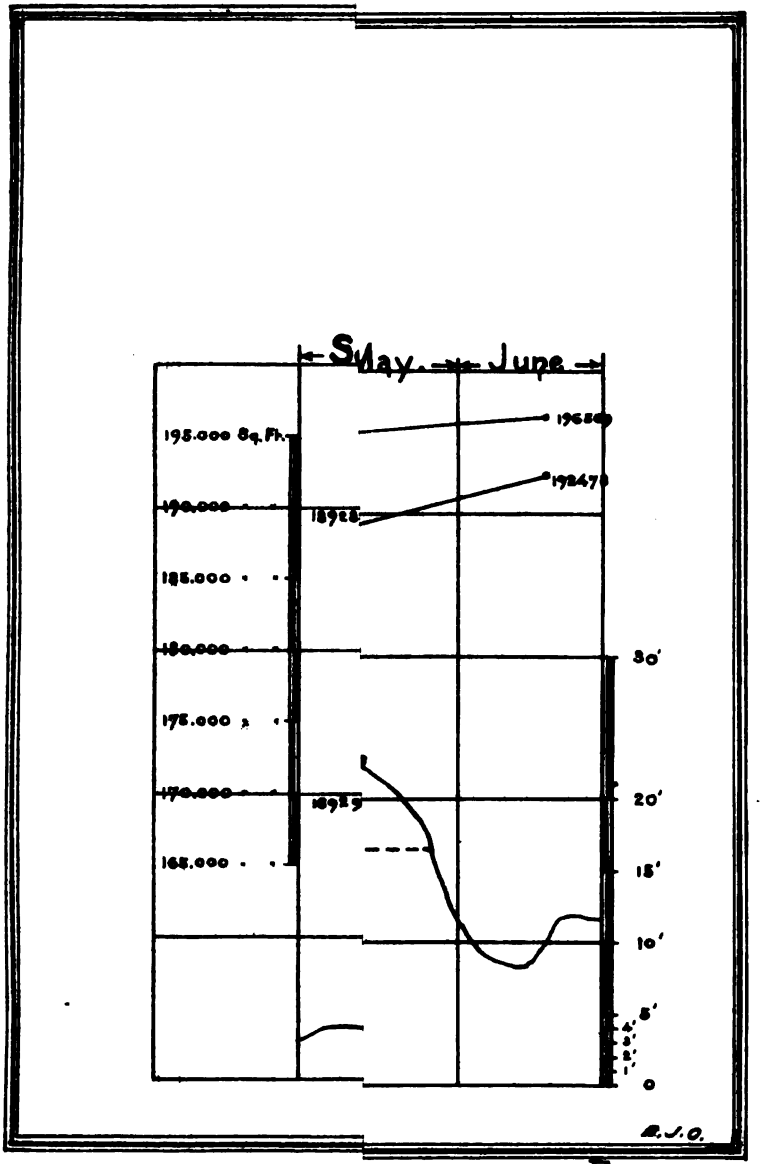
Section.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
		Sq. ft.	*Sq. ft.*	*Feet.*		*Sq. ft.*	*Sq. ft.*	*Feet*
A	Jan. 20–24, 1893	173,918		69.6	Mar. 24–28, 1893	172,379		
B	do	187,103		62.3	do	183,921		
C	do	194,102		53.3	do	178,248		
D	do	206,940	197,681	51.3	do	193,018	189,364	
E	do	202,719		50	do	195,244		
F	do	197,544		42	do	196,389		
G	do	199,622		50.9	do	197,961		
H	do	195,602	198,491	48.9	do	194,797	199,752	
I	do	201,196		51.6	do	209,864		
J	do	259,542		82.4	do	265,653		
K	do				do	417,879		
L	do				do	195,550		
M	do				do	196,922		
A	July 25–28, 1893	172,915		69.1	Sept. 20–Oct. 4, 1893	173,786		
B	do	175,642		58.5	do	178,276		
C	do	190,610		52.3	do	183,826		
D	do	199,922	190,642	49.6	do	204,318	193,448	
E	do	193,796		47.8	do	202,384		
F	do	193,241		41.1	do	198,440		
G	do	197,401		50.3	do	201,675		
H	do	196,118	198,806	49	do	195,092	201,163	
I	do	208,466		53.4	do	209,445		
J	do				do	265,819		
K	do				do	417,757		
L	do	197,711		69.9	do	199,103		
M	do	199,014		67.5	do	200,544		

BONNET CARRE.

[929 miles below Cairo, left bank. Crevasse broke (last time) April 11, 1874. Levee rebuilt Febru 1883. Approximate greatest average depth of water in crevasse 22.5 feet; greatest width feet. Greatest width (1874), 1,370 feet. Datum line for sections, high water, 35.61, Cairo da Surveys made: 1874–'75, by G. W. R. Bailey; 1878, 1880, by board of engineers of Louisiana, 188 Mississippi River Commission.]

Section.	Location above or below center of break.	Date.	Areas.	Means.	Mean depths.	Date.	Areas.	Means.	Mean depths.
	Feet.		*Sq. ft.*	*Sq. ft.*	*Feet.*		*Sq. ft.*	*Sq. ft.*	*Fe*
1	* 6,980	Sept., 1874	173,330		61.9				
2	* 5,250	do	140,346	140,148	46.3	Sept., 1875	151,450		
3	* 1,050	do	106,770		36.3				
4	† 530	do	113,710		46.2				
5	† 1,430	do	105,840	109,775	42.7	do	122,100		
6	† 4,890	do							
1		May, 1878	188,445		66.4	Feb., 1880	215,700		
2		do	153,345	153,448	47.8	do	188,390	189,223	
3		do	118,555		35.8	do	163,580		
4		do	106,310		32.6	do	171,560		
5		do	108,710	138,051	36.7	do	152,060	170,048	
6		do	169,135		58.7	do	186,525		
1		Dec., 1882	202,837		68.9				
2		do	177,032	176,079	54.9				
3		do	145,370		36.9				
4		do	145,690		37.7				
5		do		160,935					
6		do	176,180		61.2				

* Above. † Below.


May
June
195.000 Sq. Ft.
190.000
185.000
180.000
175.000
170.000
165.000
18928
18925
30'
20'
15'
10'
5'
4'
3'
2'
1'
0
A. J. O.

Eng 53 3

LOCATION OF SECTIONS
AT
BELMONT CREVASSE
SCALE
JUNE 1894.
St. Joseph.
Belle Vue.
Longue Vue.
Jolly.
Bourgeoise
Bourbon
Dupare
Armand
Belle Alliance.
Valcour Aimé
Murry
Home
Belmont.
CREVASSE
Oak Alley.
Homestead.
Bay Tree.
Theriot
Delogney
Home.
COLLEGE POINT
Pikes Peak
Cabahnocy.

N.
W.
E.
Roseland
Brul.
Good Hope
HAHNVILLE
Prospect.
935 mls. below CAIRO
CREVASSE
Speranza
Ormond
Red Church
Destrahan
Sonia
Alicia
LOCATION OF SECTIONS
AT
PROSPECT CREVASSE
SCALE
feet.
Mls.
JUNE 1894.

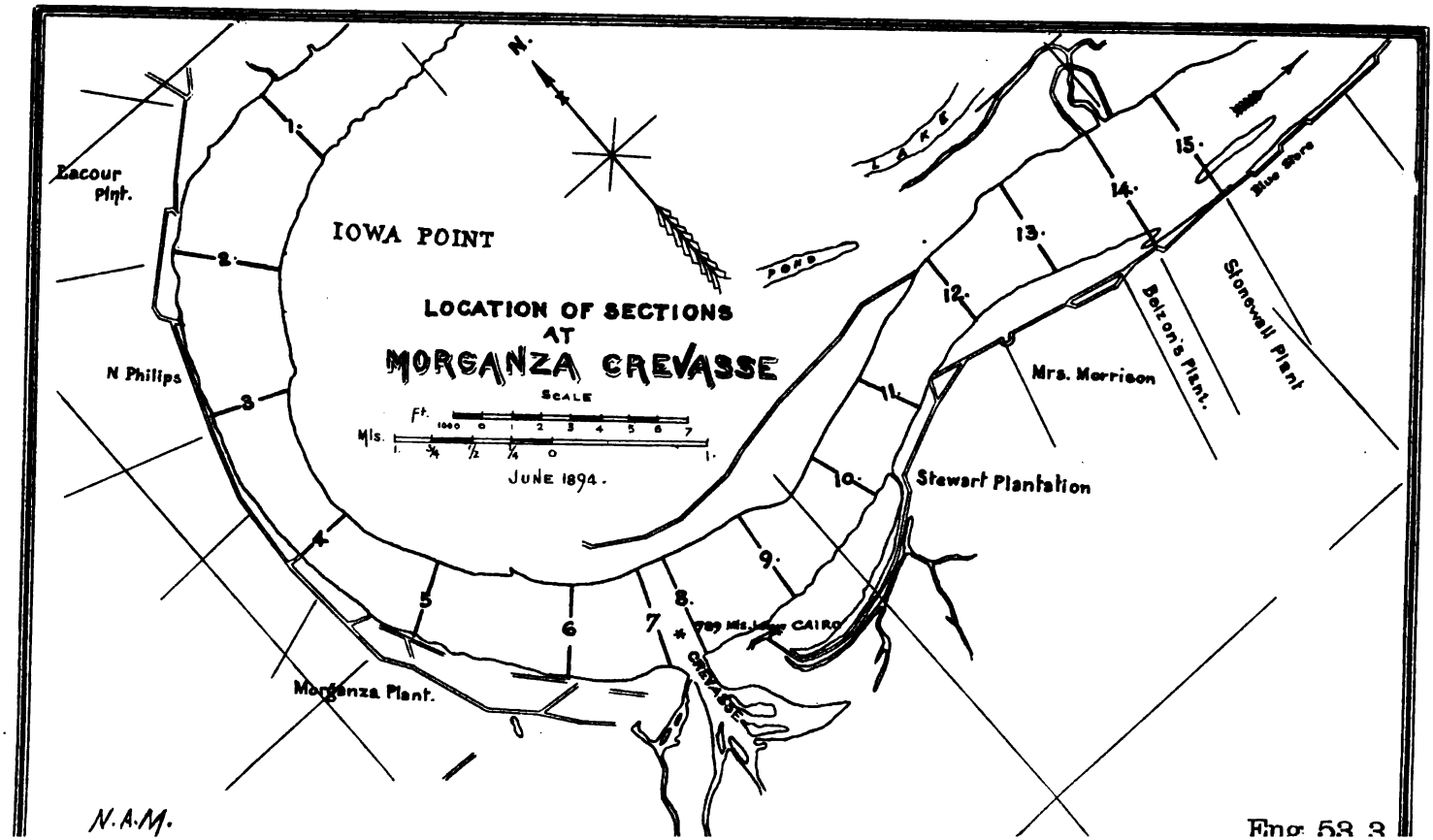
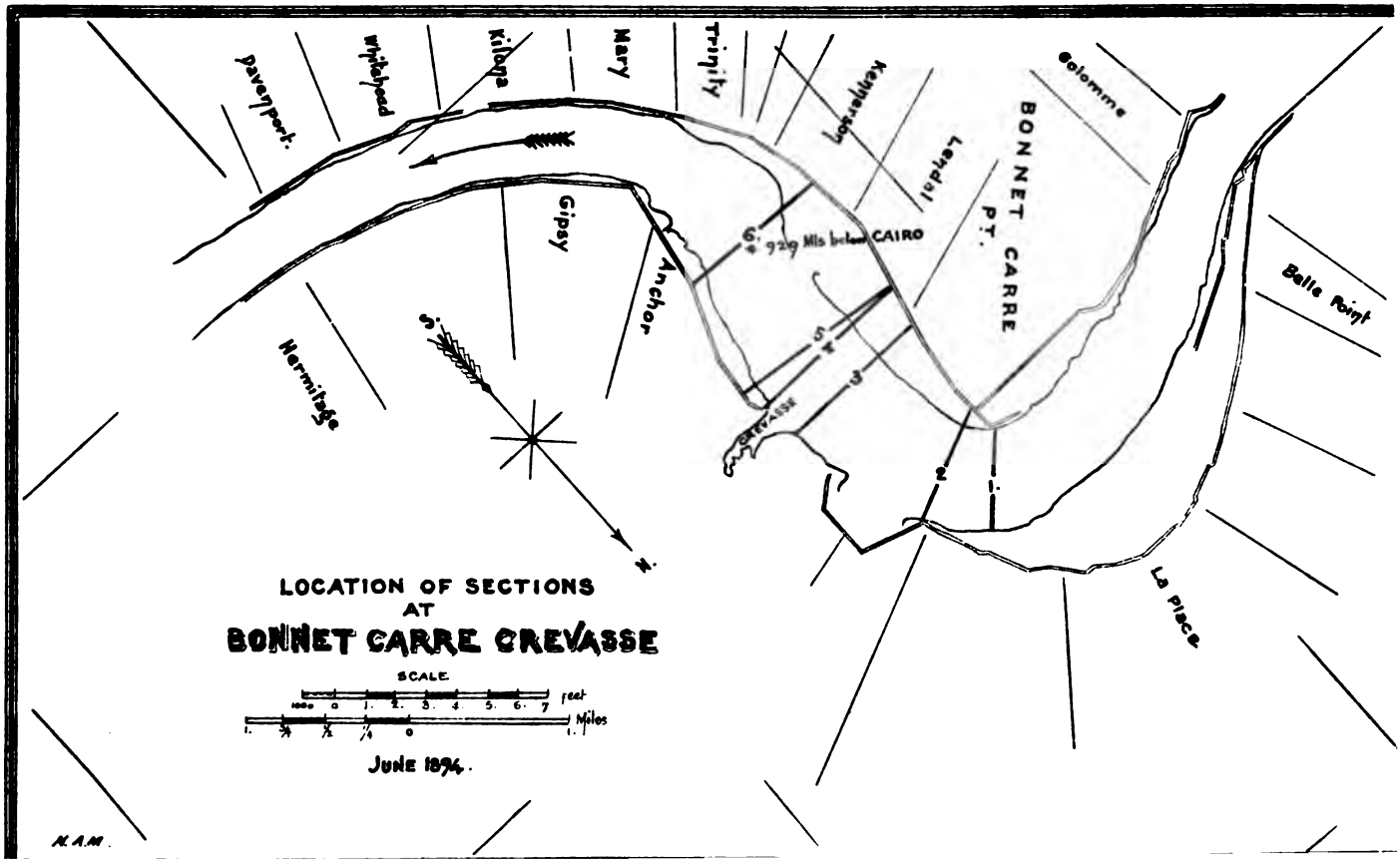
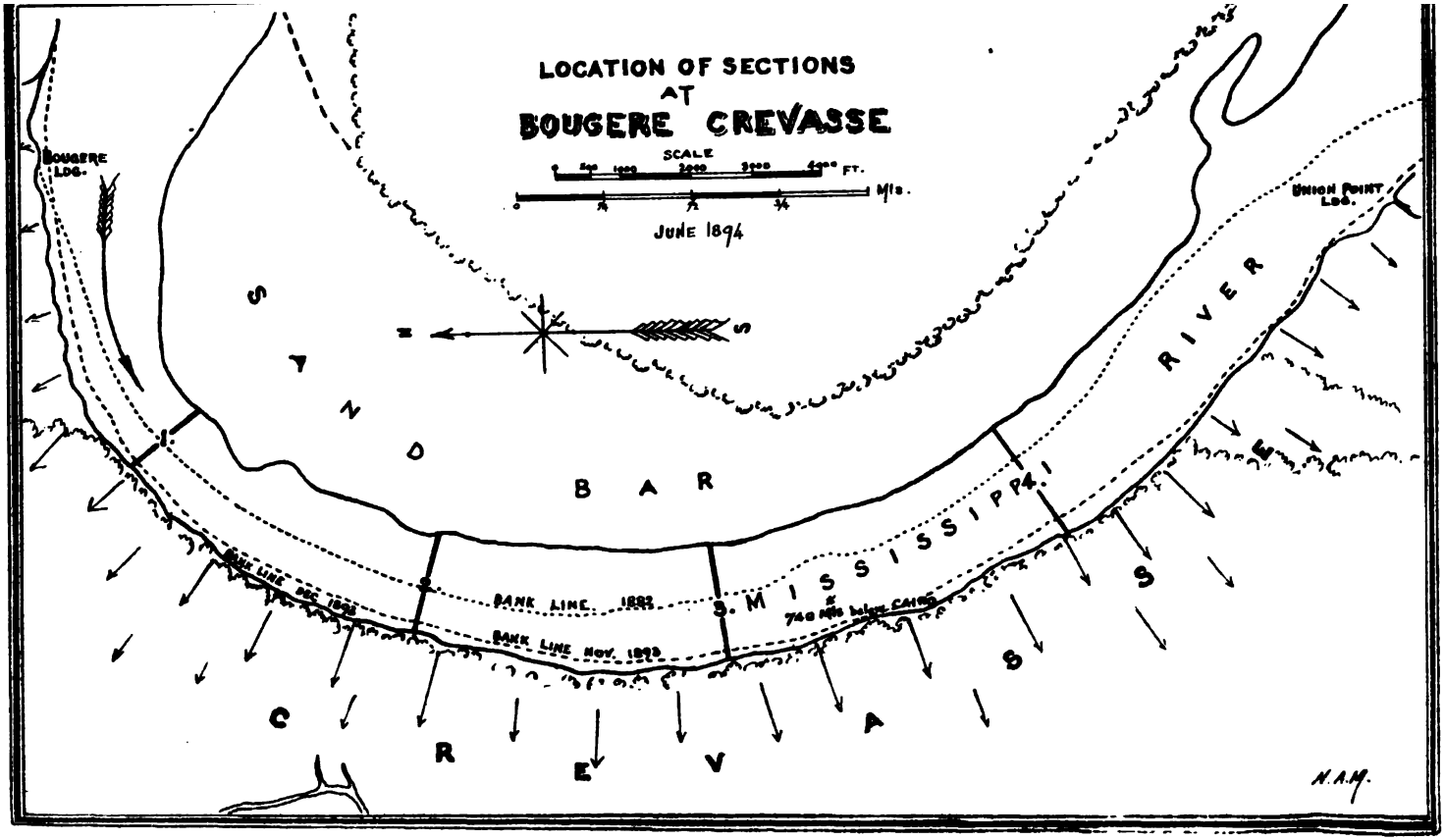

IOWA POINT
LOCATION OF SECTIONS
AT
MORGANZA CREVASSE
SCALE
Ft.
Mls.
JUNE 1894.
N.
LAKE
FORD
Eacour Plnt.
N Philips
Morganza Plant.
Stewart Plantation
Mrs. Morrison
Belzon's Plant.
Stonewall Plant
Blue Store
CAIRO
CREVASSE
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
N.A.M.

Fig. 58.3


Davenport
Whitehead
Kilbys
Mary
Trinity
Lockport
Kenilworth
Lendal
BONNET CARRE PT.
Colomma
Belle Point
La Place
Gipsy
Anchor
Hermitage
9.
929 Mls below CAIRO
5.
3.
CREVASSE
LOCATION OF SECTIONS
AT
BONNET CARRE CREVASSE
SCALE
feet
Miles
JUNE 1874.
N. A. M.


LOCATION OF SECTIONS
AT
BOUGERE CREVASSE
SCALE
JUNE 1894
BOUGERE LDG.
UNION POINT LDG.
SAND BAR
RIVER
MISSISSIPPI
BANK LINE 1882
BANK LINE NOV. 1893
CREVASSE
N.A.M.